Section 6

Plan Description

Following extensive review of the alternatives discussed in Section 2 and the decision process discussed in Section 5, it was determined that the most effective, and currently, the only available plan would be the construction of the Poplar Island project and its associated habitat development. The recommended plan for the Poplar Island Restoration feasibility study is described in this section along with the associated operation and maintenance requirements, the social and economic considerations, and the environmental consequences. The recommended plan was developed as a result of the collaborative efforts of the multi-agency study team described in Section 1. The result is a multi-objective plan which will support a wide diversity of fish and wildlife habitat. The following sections describe and document the engineering and environmental characteristics of the proposed alignment.

6.1 Description of the Recommended Plan

As described in Section 5, the recommended alignment encompasses approximately 1110 acres containing 50 percent tidal wetlands (80 percent low marsh and 20 percent high marsh) and 50 percent uplands with an upland elevation of up to +20' MLLW. The proposed alignment was selected based on comparative analysis of costs, soil conditions, capacity, borrow requirements, wetlands development, engineering efficiency, and hydrodynamics.

The Poplar Island Restoration Project involves constructing initial dikes around the island's 1847 footprint, raising some of the initial dikes up to elevation 23 MLLW, and filling the enclosed area with clean dredged material from the Baltimore Harbor approach channels. The filled areas would be developed into wetlands and upland habitat. The preferred dike alignment for Poplar Island would create a 1,110-acre dredged material placement area within a 35,000-foot perimeter (Figure 6-1). The dike would surround the entire placement area, including the four small remnant islands and the area south of Coaches Island. However, the dike would not connect directly to Coaches Island. Along the dike alignment to Coaches Island, a sand dune configuration is currently proposed that would allow for a small tideway to remain open between Coaches Island and the project. The State of Maryland intends to purchase 2.83 acres on Coaches Island. This includes a 5-foot strip along the south shore and a small peninsula. This area is marshland and totals 2.23 acres. The State intends to also purchase 0.6 acres of fastland along the 5-foot strip.

The dikes will be constructed by hydraulic dredging of sand from within the project area. Hydraulically placed sand will provide adequate geotechnical stability at the lowest cost per linear unit of dike structure. A detailed optimization analysis has been made to determine the conditions (i.e., design return periods for waves and water levels) that will serve as the basis

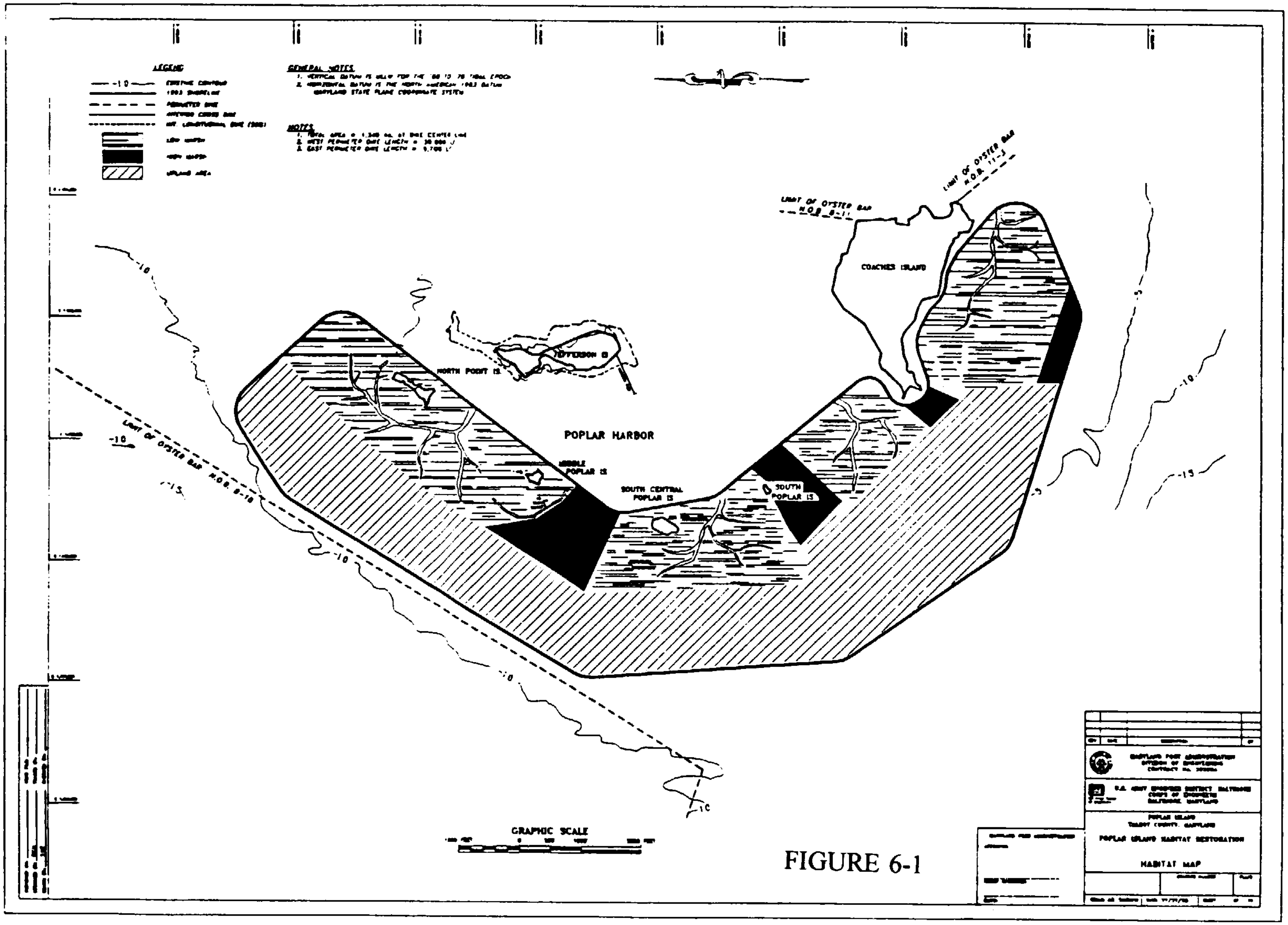

LEGEND
GENERAL NOTES
NOTES
LIMIT OF OYSTER BAR
COACHES ISLAND
NORTH POINT IS
POPLAR HARBOR
MIDDLE POPLAR IS
SOUTH CENTRAL POPLAR IS
SOUTH POPLAR IS
GRAPHIC SCALE
HABITAT MAP

FIGURE 6-1

for final design of the armor stone for the exterior slope of the perimeter dikes (GBA-M&K J.V. 1995a). The analysis considered an armored western dike and both armored and unarmored eastern dike alternatives (Figures 6-2 to 6-4). The recommended design for the western perimeter dike consists of a sand dike with 3H:1V exterior slopes protected with 1.5 to 2.0 ton armor stone up to elevation 11.5, an overbuilt interior section with 5H:1V slopes, and an unarmored dike section from elevation 11.5 to 23.0 constructed with sand under a later contract. Those interior dikes providing containment for the upland cells would also consist of a sand dike to approximately elevation 10 or 11 with an overbuilt interior slope, and would also be raised to elevation 23.0 using sand from an outside borrow source under later contract. The armored eastern dike would have a 3H:1V exterior slope with 250-pound armor, and a crest elevation of 8 feet. The eastern dike would not have to be raised since it contains the wetland cells. An unarmored reach of the eastern dike which parallels Coaches Island would have 5H:1V slopes and a crest elevation of 8.0.

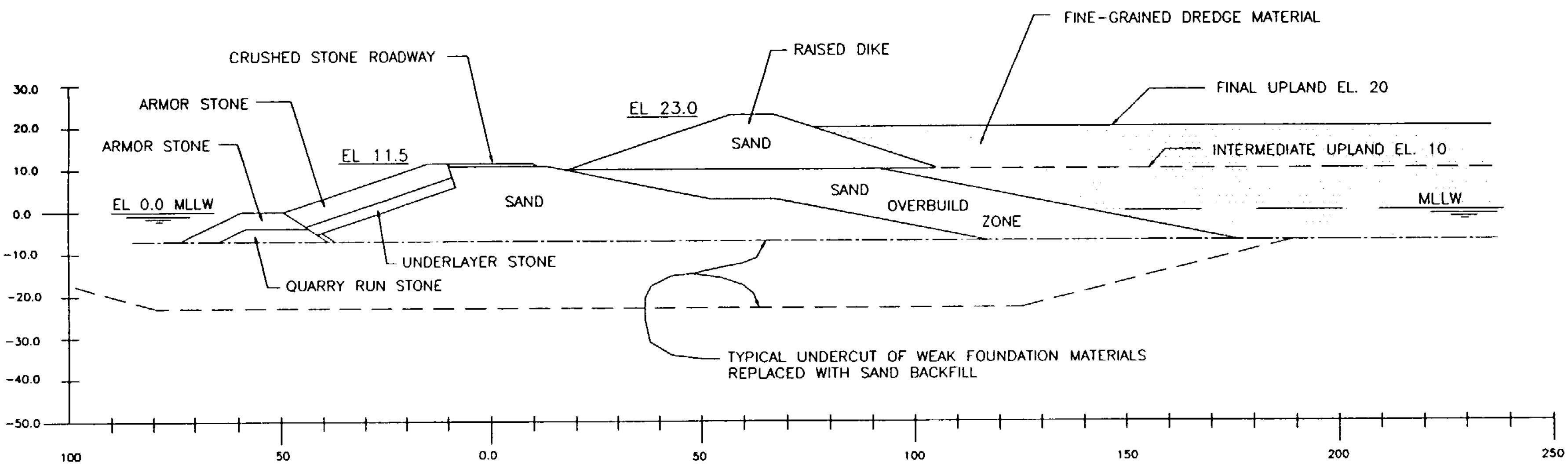
The plan for the placement area proposes 50 percent wetland and 50 percent upland habitats. Final configuration will include submerged aquatic habitat below the lower spring low water, mudflat, low marsh, high marsh, and upland (Figure 6-5; Table 6-1).

Table 6-1 Tidal Wetland Elevations and Habitats

		Elevation (ft) MLLW	Habitat Type
Lower Spring Low Water	LSLW	-0.6	Aquatic
Mean Lower Low Water	MLLW	0.0	Mudflat
Mean Spring Low Water	MSLW	0.25	Mudflat
Mean Low Water	MLW	0.3	Mudflat
Nat'l Geodetic Vertical Datum	NGVD	0.35	Mudflat
Mean Tide Level	MTL	0.9	Low Marsh
Mean High Water	MHW	1.5	Low Marsh
Mean Higher High Water	MHHW	1.8	High Marsh
Mean Spring High Water	MSHW	2.4	Upland
	---	>2.4	Upland

Source: GBA and M&N 1995a.

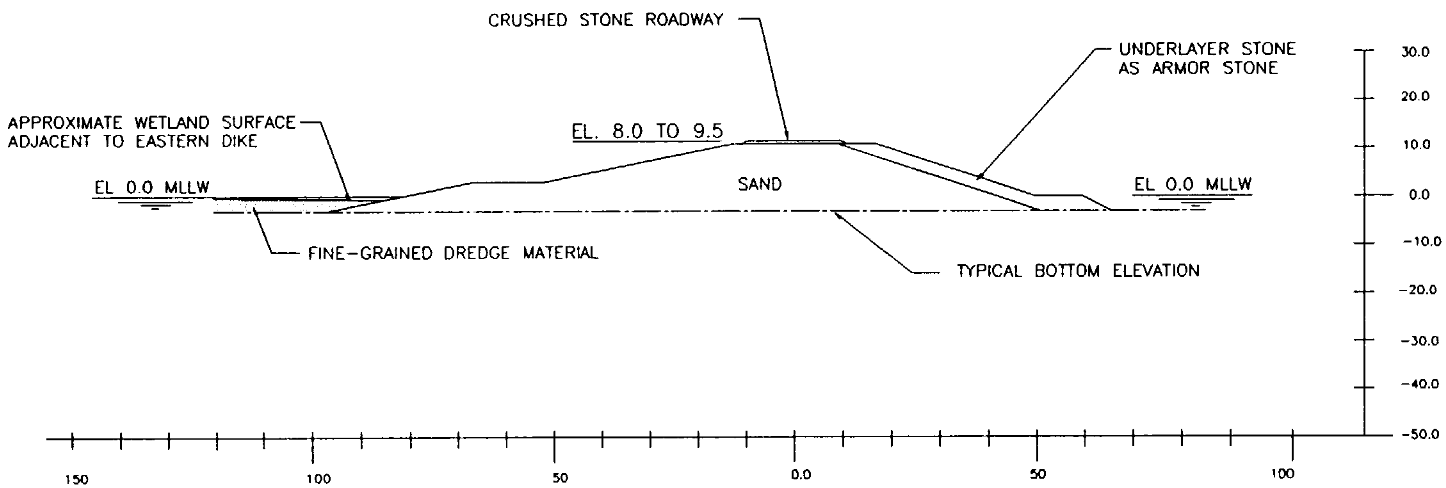
Vegetation types by planting zone to be used are indicated in Table 6-2.



TYPICAL WESTERN PERIMETER DIKE SECTION

SCALE: 1"=40' (HOR & VERT)

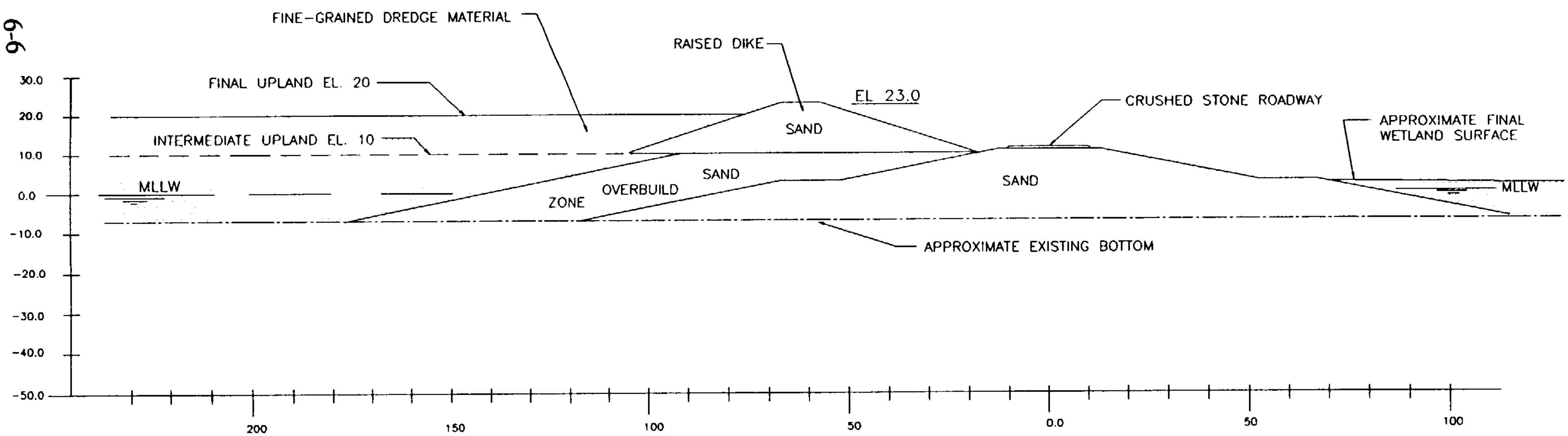
FIGURE 6-2



TYPICAL EASTERN PERIMETER DIKE

SCALE: 1"=40' (HOR & VERT)

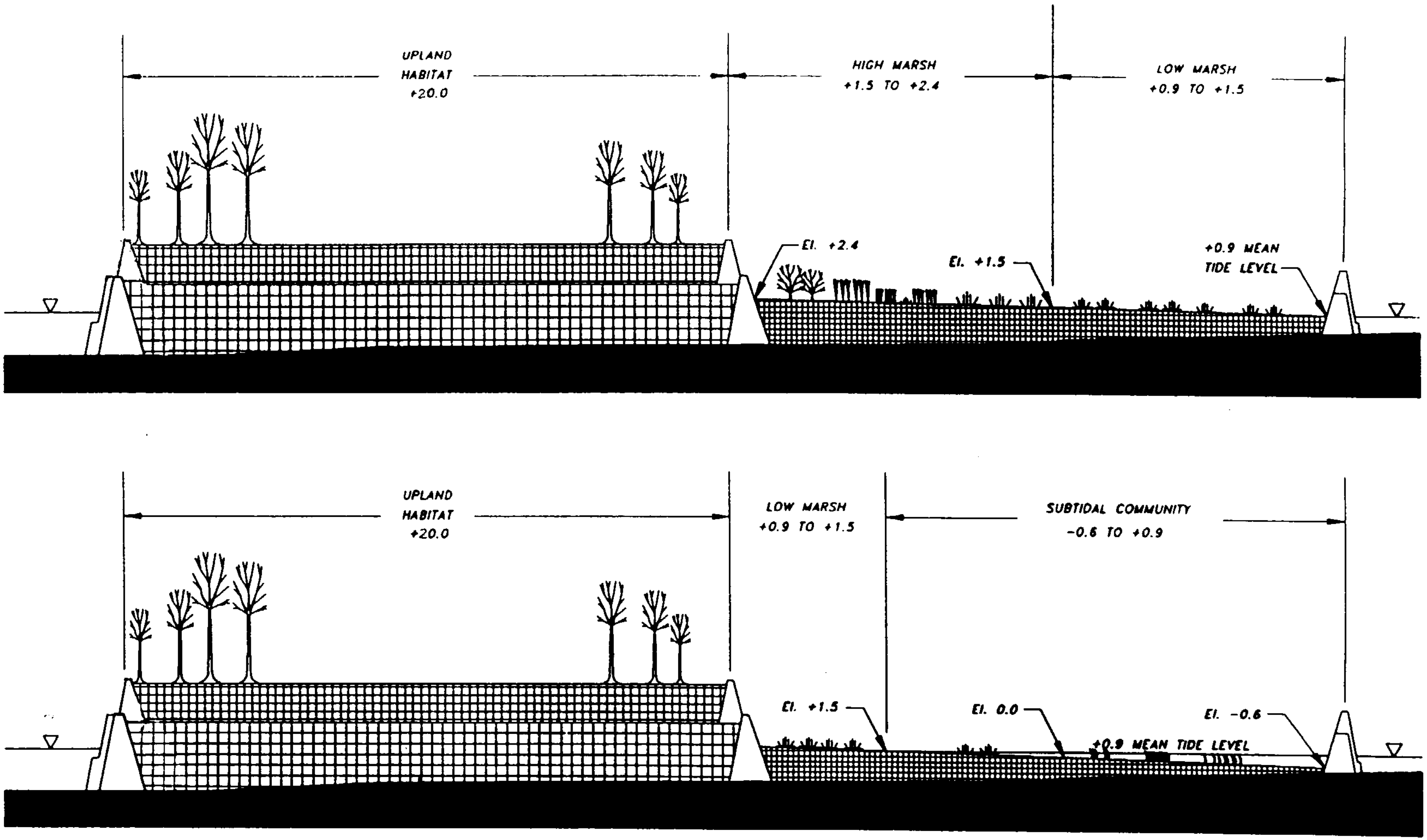
FIGURE 6-3



<u>TYPICAL INTERIOR LONGITUDINAL DIKE</u>

SCALE: 1"=40' (HOR & VERT)

FIGURE 6-4



NOTES

1. Vertical datum is MLLW for the '60 to '78 tidal epoch.
2. All elevations are in feet.

Figure 6-5 Typical island section - 50% wetlands and 50% upland.

Table 6-2
Vegetation Types by Planting Zone

Planting Zone	Tidal Range MLLW	Vegetation Type
Mudflat	-0.6 to 0.9	None
Low Marsh	0.9 to 1.5	Cordgrass
Low Marsh	1.3 to 1.5	Cordgrass Seed
High Marsh	1.5 to 2.4	Salt Hay
Upland	>2.4	Grasses, woody vegetation 1/

1. Initial plantings will be annual rye, tall fescue, panic grass if salt leaching is required
Source: GBA-M&N J.V. 1995c.

6.1.2 Project Features

The perimeter dike will contain the dredged material and provide coastal protection for the placement and habitat restoration site. Specifically, the perimeter dike will be designed to contain loose, fine-grained dredged material derived from the Baltimore Harbor Approach Channels. This will be achieved through the use of specific dike core material and construction geometry. The perimeter dike will be exposed to two principal wave regimes: (1) relatively high waves from the north, west, and south, and (2) relatively low waves from the east and southeast and within the interior of the containment dike. The portion of the perimeter dike exposed to high-energy wave attack is referred to as the Western Perimeter Dike, and the portion exposed to low-energy wave attack is referred to as the Eastern Perimeter Dike.

Geotechnical site investigations, subsurface explorations, soil testing, and the containment dike design were accomplished by Earth Engineering and Sciences, Inc. under a contract with Gahagan & Bryant Associates-Moffat Nichol, Engineers, Joint Venture, consultants to the MPA. Results of investigations and design are presented in a series of geotechnical reports not included in this report.

Approximately 85 Standard Penetration Test borings and 62 Cone Penetrometer Tests accomplished at the Poplar Island site indicated that the foundation soils can be grouped into four strata: 1) very soft normally consolidated recent deposits of silty clay, sporadically located near the surface; 2) a superficial silty sand, 0 to 30 feet in thickness; 3) soft to hard silty clay, 0 to 20 feet in thickness; and 4) stiff clay with pockets of sand at depth beneath the entire site. Based on the results of the foundation investigations, it was determined that the containment dike will be constructed with fine silty sands hydraulically dredged from the project area. Analyses indicate that the dikes can be constructed generally to approximately 5H on 1V slopes. The outer slope will be mechanically shaped to 3H on 1V prior to placement of armor stone in order to minimize the quantity of armor stone required for wave protection. A geotextile fabric and underlayer stone will be placed on the outer slope of the dike prior to placement of the armor stone. The fabric is necessary to prevent the sand in the dike from eroding out through the armor stone layers. Slope stability analyses indicated that the slopes will be stable on the sand foundation. The soft deposits of silty clay located sporadically along the western dike alignment will be removed prior to construction of the dike to insure stability, and eliminate any potential long-term settlement concerns. The smaller, more lightly armored eastern dike will be temporarily overbuilt in lieu of removing the soft foundation deposits. After displacements have occurred, final grading will be accomplished and the armor stone will be placed.

The initial armored perimeter dikes and internal dikes will be built to allow the placement of dredged materials to approximately elevation 10. The dikes providing containment of the upland cells will be raised to elevation 23 to allow development of the upland cells to approximately elevation 20. The extent of removal of weak foundation soils will be sufficient to assure stability of the dike section of the final crest elevation. The interior slope of the initial dikes will be overbuilt by approximately 75 feet at the crest and 60 feet at the base to provide a reliable foundation for the raising. The raising will be accomplished using sand obtained from a borrow site immediately south of the project on either side of the approach channel, or sand generated by channel dredging work. This approach assures that upland habitat can be accomplished to elevation 20 as proposed.

The method preferred by MPA for raising the Poplar Island dike from 10 feet to 23 feet consists of using dried material by intensive crust management along the perimeter of the upland cells. Confidence in this method is based on experiences at Hart-Miller Island. However, the initial 10-foot raising of the Hart-Miller dikes was accomplished using sand placed on the interior slope of the initial sand dike. Minimal dredged material was involved. Through crust management activities, a 100-foot wide platform of dried dredged material has recently been created inboard of the initial raised dike. This platform will support the proposed second dike raising of approximately 16 feet which has not yet been constructed. Essential to the success of this approach at Poplar Island is the limitation of dredged material lift thickness to 2 to 3 feet so that crust development can be accomplished. If even a single thick lift occurs, or if weather conditions inhibit crust development, the stability of the future raised dikes would be jeopardized. In addition, it would be difficult to generate the volume of material required to construct the required crust platform and the dikes even if a large dragline with a 150-foot reach was utilized. The risks of not being able to achieve elevation 23, or having to expend significant additional funds to achieve that elevation, are significantly greater for the crust management approach compared to the overbuild approach.

In order to verify the constructability of the proposed containment dike, the Baltimore District awarded a contract to C.J. Langenfelder & Son, Inc., to construct a 600-foot-long test dike section along a reach of the alignment during the summer of 1995 (Figure 6-6). Primary objectives of the test dike were to determine initial slopes of hydraulically dredged sands; appropriate equipment required to shape external slopes; steepest external dike slopes that can be achieved by shaping in order to verify armor stone quantities; wave erosion rates on external slopes to define the maximum length of time available to complete armoring;

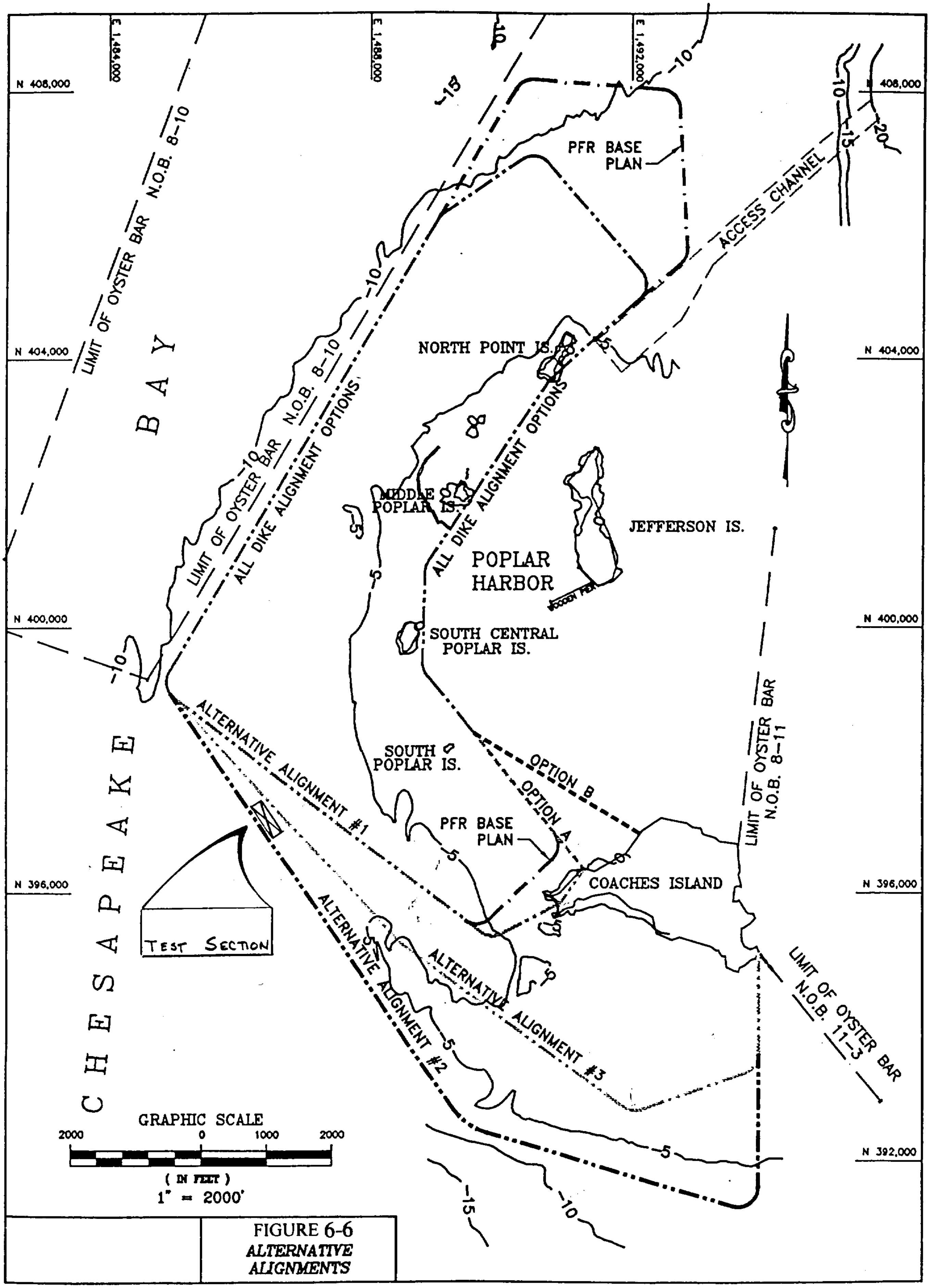


FIGURE 6-6
ALTERNATIVE ALIGNMENTS

effectiveness of construction methodologies; effectiveness of an alternative methodology utilizing sand-filled geotextile tubes to provide containment and interior cross dikes; turbidity levels during construction; and verification of the suitability of the fine sands in the borrow area.

During construction of the test dike with the fine sands in the borrow area, it was observed that the fine sand is extremely vulnerable to erosion, even during normal wave and tidal conditions. Therefore, it will be advantageous to construct the rock toe segment of the dike in advance to provide containment, and possibly to overbuild the rock toe to provide dissipation of wave energy to keep the fine sand in place until shaping and armoring can be accomplished. Also, it may not be possible to construct and maintain the interior of the containment dike slopes, or the interior cross dike slopes, at the 5H on 1V slopes originally proposed. An overbuilt section may be required within the range of normal wave and tidal activity to provide greater assurance of a stable final slope configuration. In addition, it may be necessary to provide for erosion above the normal tidal range caused by storms during the construction period by overbuilding the interior dike slope, or applying stone slope protection. Sand-filled tubes proved to be a technically feasible alternative containment structure. Although the selected hydraulically dredged sand dikes are more conventional, a contractor could submit a proposal to use sand-filled geotextile tubes. Sand-filled geotextile tubes could also be used for interior cross dikes. Information obtained from the test dike section relative to geometry and construction methodologies has been incorporated into the design, and will be included in the project plans and specifications.

Coastal Engineering investigations were accomplished by Moffat Nichol Engineers under a contract between Gahagan & Bryant-Moffat Nichol Engineers, Joint Venture, and the MPA. Detailed results of the investigations and designs are presented in the Hydrodynamic and Coastal Engineering Report prepared by Moffat Nichol Engineers for the MPA.

The Coastal Engineering investigations focused on defining the minimum crest elevation, exterior dike slopes, and armor stone required for the dikes built under the initial construction contract. The future unarmored raised dikes were not included in this part of the design effort. The discussions and Figures (6-8 through 6-13) reflect only the initial dike to maximum elevation 11.5, not the complete dike ultimately raised to elevation 23 feet. The elevations of the initial dikes were established based on a Type I dike structure, having only armor on the front slope and sand on both the crest and the back slope. Therefore, the heights of the initial dike were determined based on an allowable overtopping rate of 5 liters per meter per second for the 25-year design storm. For this condition, the initial perimeter dike would remain stable and protect the set-back raised dike section. However, storm events greater than the design event could potentially erode portions of the raised dike, requiring remedial measures.

The basic approach for the design of the initial dikes was to approximate the local wind climate, and employ this information toward the derivation of a design wave climate. Water levels are also an important consideration in the dike design. Design water levels in the study area are dominated by storm effects. The wind and water level information used for the design are presented in Section 3. Using the wind and water level information, a design wave climate was developed using procedures recommended by the Shore Protection Manual (SPM 1984).

The design was based on an optimized approach that attempts to obtain a balance between initial construction costs and maintenance costs associated with storm-induced damages to the containment dikes. Using the wave climate and water level information previously developed, the optimization analyses lead to the selection of the return period for waves and water levels that obtain this balance.

The basic approach consisted of developing a series of dike designs and construction cost estimates for various design levels. Total present worth maintenance costs were then developed based on damage estimates to the structure due to storm events exceeding the various designs. Curves of these present worth values per return period were then developed. Figure 6-7 shows an example plot of present worth costs. As can be seen from the figure, initial capital costs increase with increasing return period while maintenance costs decrease with increasing return period.

The optimization analysis considered an armored western perimeter dike and both an armored and unarmored eastern dike alternatives. The analysis indicated that the most cost-effective design was an armored western dike with a crest elevation of 11.6 feet MLLW, structure slope of 3H:1V, and 3,000-pound armor stone, and an armored eastern dike with a crest elevation of 8.0 feet MLLW, structure slope of 3H:1V, and 400-pound stone.

Physical model testing was then conducted to verify the western dike section design, which was based on the cost optimization analyses. Also, dike cross-sections with various water depths were evaluated. Data obtained from the physical model testing were used to finalize the design. Pertinent data included measurement and verification of the proposed armor size gradation, measurement of the significant and maximum wave height at the structure, measurement of wave overtopping, and observance of rock movement and/or displacement.

Evaluation of test results and previous analysis resulted in the selection of six design sections. Figures 6-8 through 6-13 present the dike cross-sections for typical sections along the perimeter dike alignment. Figure 6-8 shows a western dike section in 5 feet of water that has a crest elevation of +9.5 feet MLLW, includes two layers of 3,000-pound armor stone, and two layers of 250-pound underlayer stone overlying a geotextile that separates the stone revetment from the dike core. Figure 6-9 shows a western dike section in 7 feet of water that has a crest elevation of +10.5 feet MLLW and includes two layers of 3,000-pound armor stone and two layers of 250-pound underlayer stone overlying a geotextile. Figure 6-10 shows a western dike section in 8 feet of water that has a crest elevation of +11.0 feet MLLW and includes two layers of 4,000-pound armor stone and two layers of 250-pound underlayer stone overlying a geotextile. Figure 6-11 shows a western dike section that has a crest elevation of +11.5 feet MLLW, and includes two layers of 4,000-pound armor stone and two layers of 250-pound underlayer stone overlying a geotextile. Figure 6-12 shows an

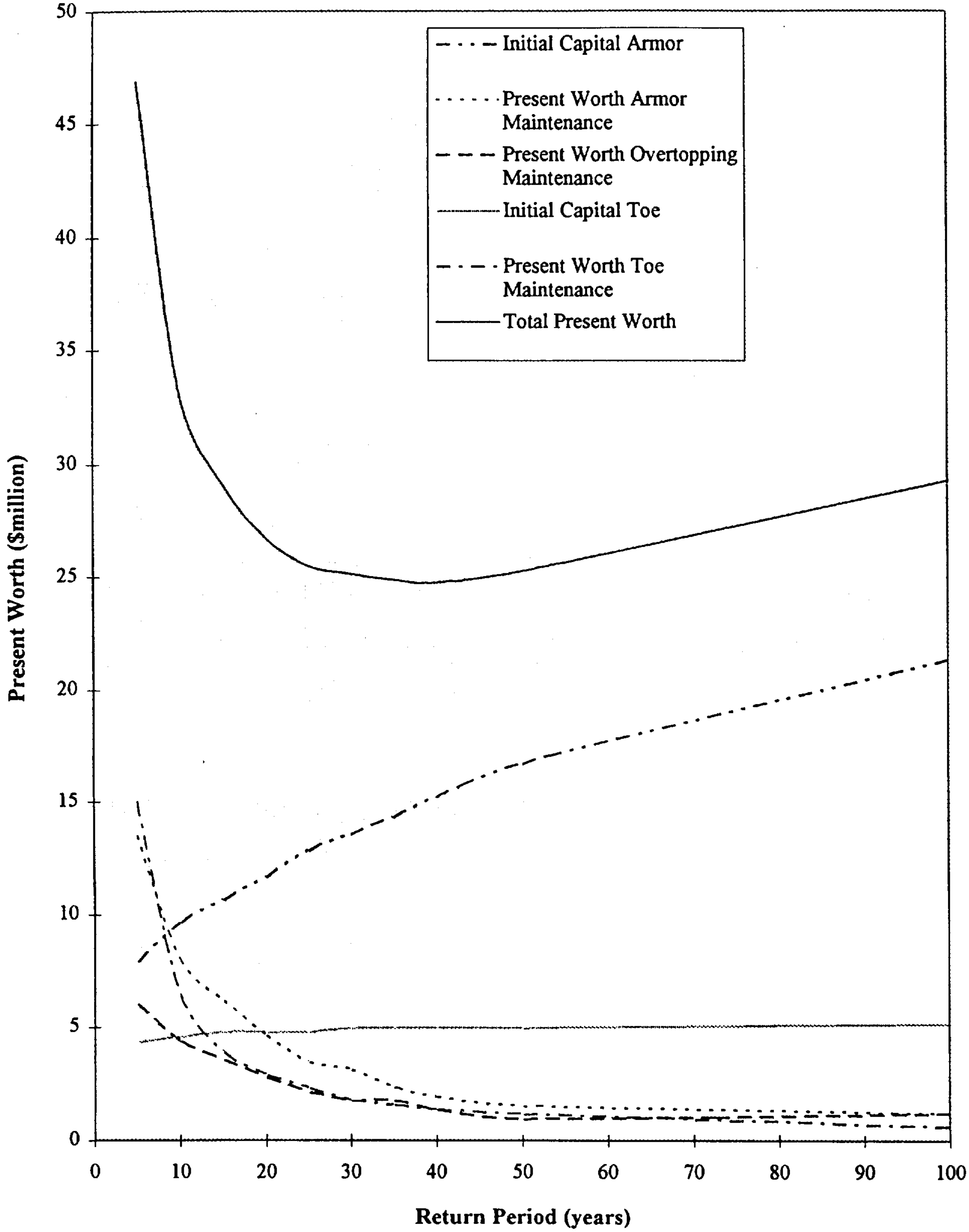
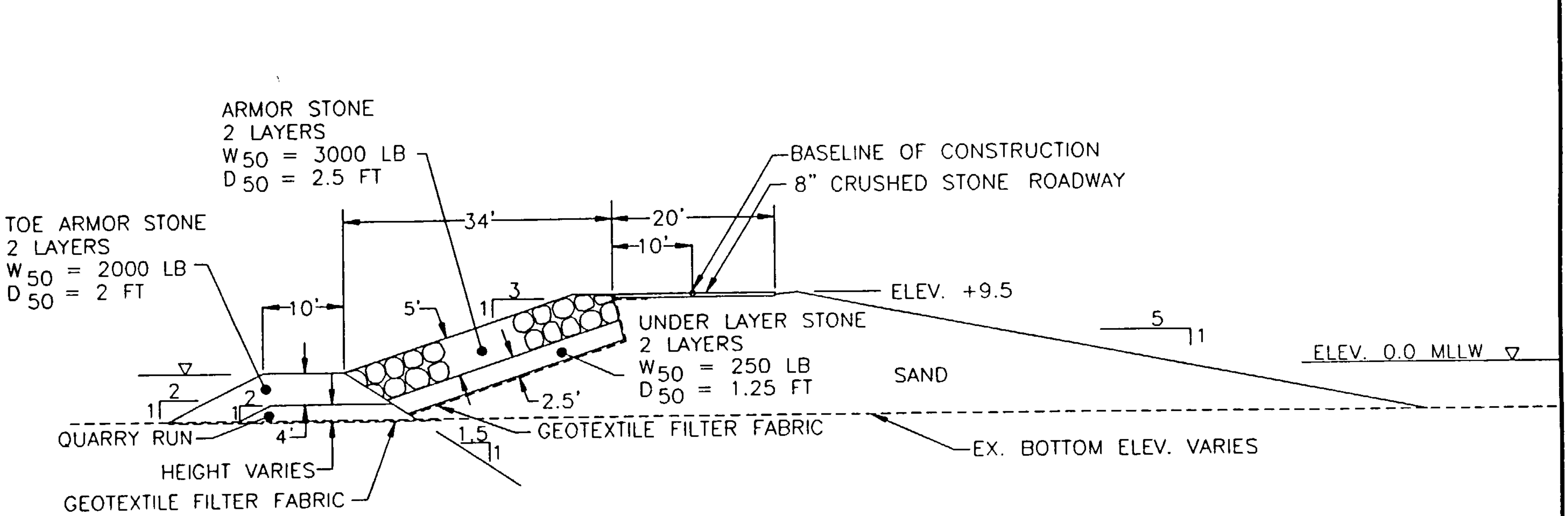


FIGURE 6-7 PRESENT WORTH COSTS FOR 3.0:1 SLOPE

GAHAGAN & BRYANT
MOFFATT & NICHOL
A JOINT VENTURE

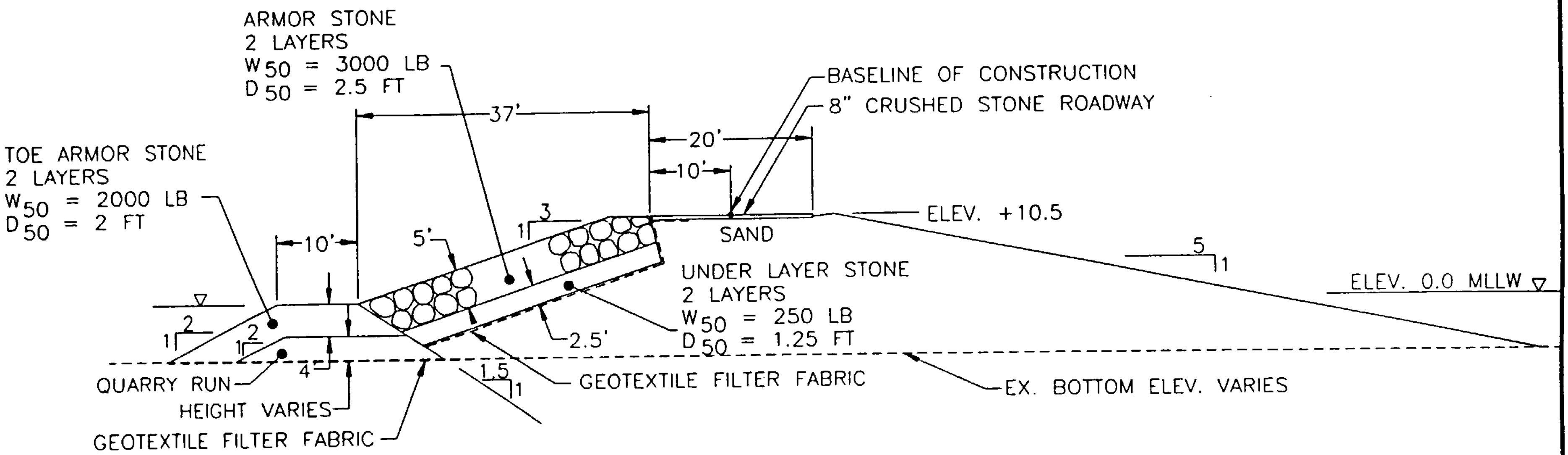


TYPICAL DIKE SECTION No. 1

STA 183+00 to 192+00
STA 335+00 to 394+00

FIGURE 6-8
TYPICAL DIKE SECTION NO. 1

GAHAGAN & BRYANT
MOFFATT & NICHOL
A JOINT VENTURE

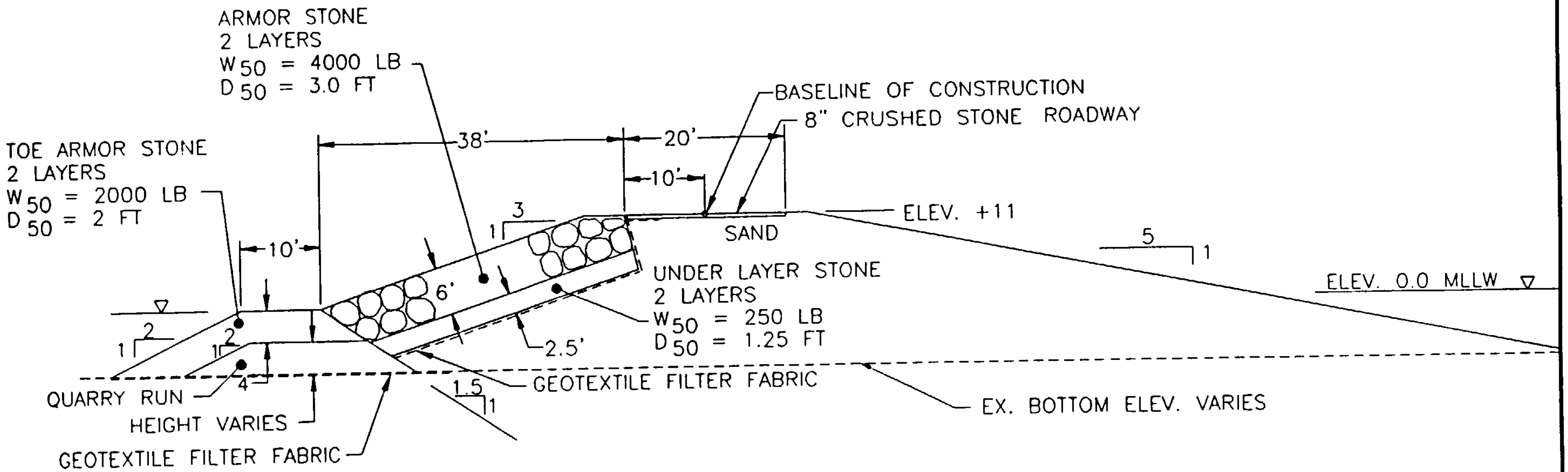


TYPICAL DIKE SECTION No. 2

STA 1+48 to 98+64

SCALE 0 5 10 20 30

FIGURE 6-9
TYPICAL DIKE SECTION NO. 2



TYPICAL DIKE SECTION No. 3

98+64 to 137+00

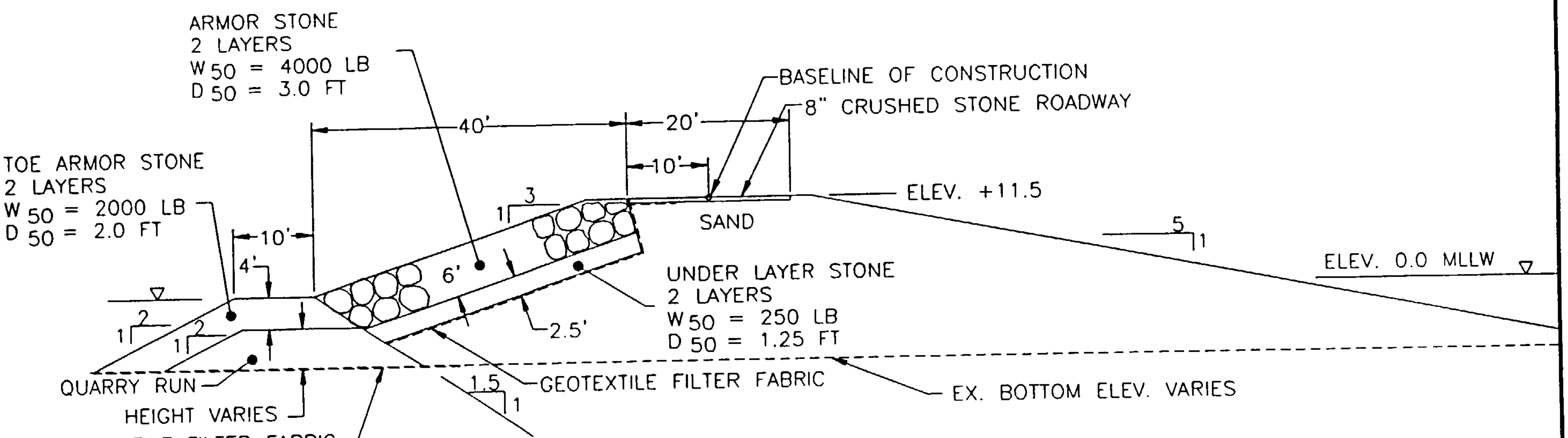
GAHAGAN & BRYANT
MOFFATT & NICHOL
A JOINT VENTURE

SCALE 0 5 10 20 30

FIGURE 6-10
TYPICAL DIKE SECTION NO. 3

GAHAGAN & BRYANT
MOFFATT & NICHOL
A JOINT VENTURE

0 5 10 20 30
SCALE



TYPICAL DIKE SECTION No. 4

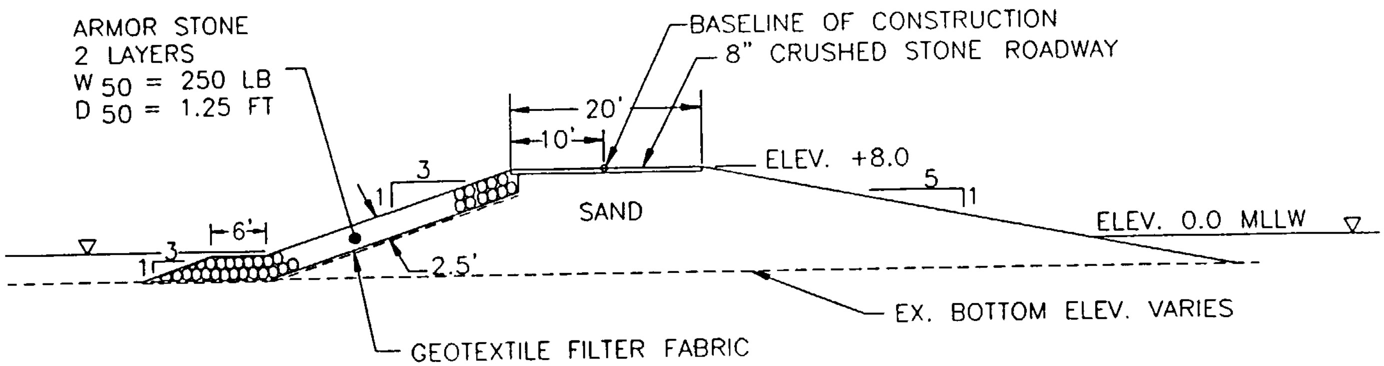
STA 137+00 to 183+00

FIGURE 6-11
TYPICAL DIKE SECTION NO. 4

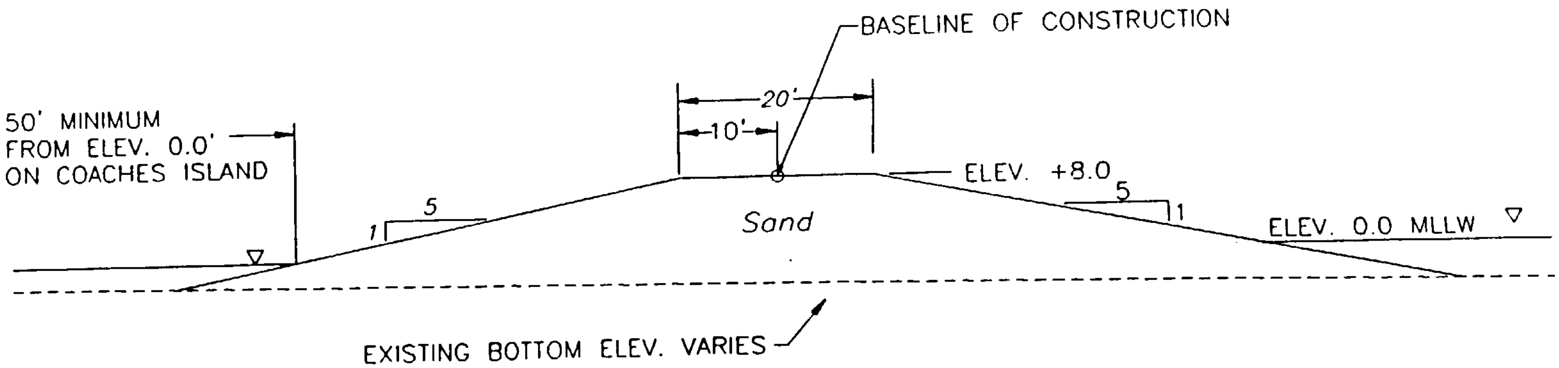
GAHAGAN & BRYANT
MOFFATT & NICHOL
A JOINT VENTURE

SCALE 0 5 10 20 30

FIGURE 6-12
TYPICAL DIKE SECTION NO. 5



TYPICAL DIKE SECTION No. 5
STA 192+00 to 290+00



TYPICAL DIKE SECTION No.6

STA 290+00 to 338+00

GAHAGAN & BRYANT
MOFFATT & NICHOL
A JOINT VENTURE

FIGURE 6-13
TYPICAL DIKE SECTION NO. 6

eastern dike section in 3 feet of water that has a crest elevation of +8.0 feet MLLW and includes two layers of 250-pound armor stone overlying a geotextile. Figure 6-13 shows a dike section to be used along Coaches Island in 3 feet of water that has a crest elevation of +8 feet MLLW and consists of sand with no rock protection.

The most likely mode of failure of the containment dike would be the result of the failure of the armor stone. A reliability analysis of the armor design was conducted to assess this risk. The analysis provides a probability-based means for evaluating the risk of damage to the armor stone throughout various time periods. Risk-based computations of the failure probability were performed using a reliability function. Input variables to the reliability function include wave height, water depth, median rock diameter, and structure slope. Probability of exceedence of different damage levels over various time periods were then performed using a Monte Carlo simulation technique. Figure 6-14 shows an example of the results obtained in the form of a plot of probability of exceedence versus armor damage. A damage level of 4 indicates the onset of tolerable damage. The results show that there is a 52% chance that a western dike in 7 feet of water will exceed an armor damage level of 4 over a 20-year period. Similar analyses were performed for various water depths and for the eastern dike. The findings of high probabilities of dike damage were to be expected and these findings have been incorporated into the optimization analyses.

6.1.2.a Western Perimeter Dike. A preliminary design and construction staging for the western perimeter dike is shown in Figure 6-15. The armored toe dike provides protection to the adjacent oyster bar along the western dike during hydraulic placement of sand and provides partial protection to the sand core prior to completion of the slope protection.

6.1.2.b Eastern Perimeter Dike. The eastern perimeter dike generally follows the 1847 shoreline of the former Poplar Island. This portion of the perimeter dike is exposed to relatively low waves and will not have to be protected to the same degree as the western dike. Two slope designs were considered for the eastern dike: (1) an armored rock dike, and (2) an unarmored sand dike. The two design options are summarized in Figure 6-16.

6.1.2.c Interior Dikes. Interior dikes will be required to accommodate the large elevation difference between the wetland and upland cells and to support sequential development of wetland habitats. For example, an interior dike will allow early development of an initial wetland cell soon after the initial placement of material. There will be four primary wetland and two upland cells. Partitioning of the larger-sized wetland cells into smaller cells may also prove to be advantageous.

Wetland cross dikes will have slopes of 5H:1V, crest elevations of 8 feet, and crest widths of 20 feet. Longitudinal and upland dikes will have slopes of 5H:1V, with initial crest elevations of 10 feet and crest widths of 20 feet. Longitudinal dikes and the western perimeter dike will be raised to 23 feet. The raised dikes will have slopes of 3H:1V and crest widths of 10 feet.

Probability of Exceedence of Damage Level S in Lifetime of Structure for 7 ft Water Depth

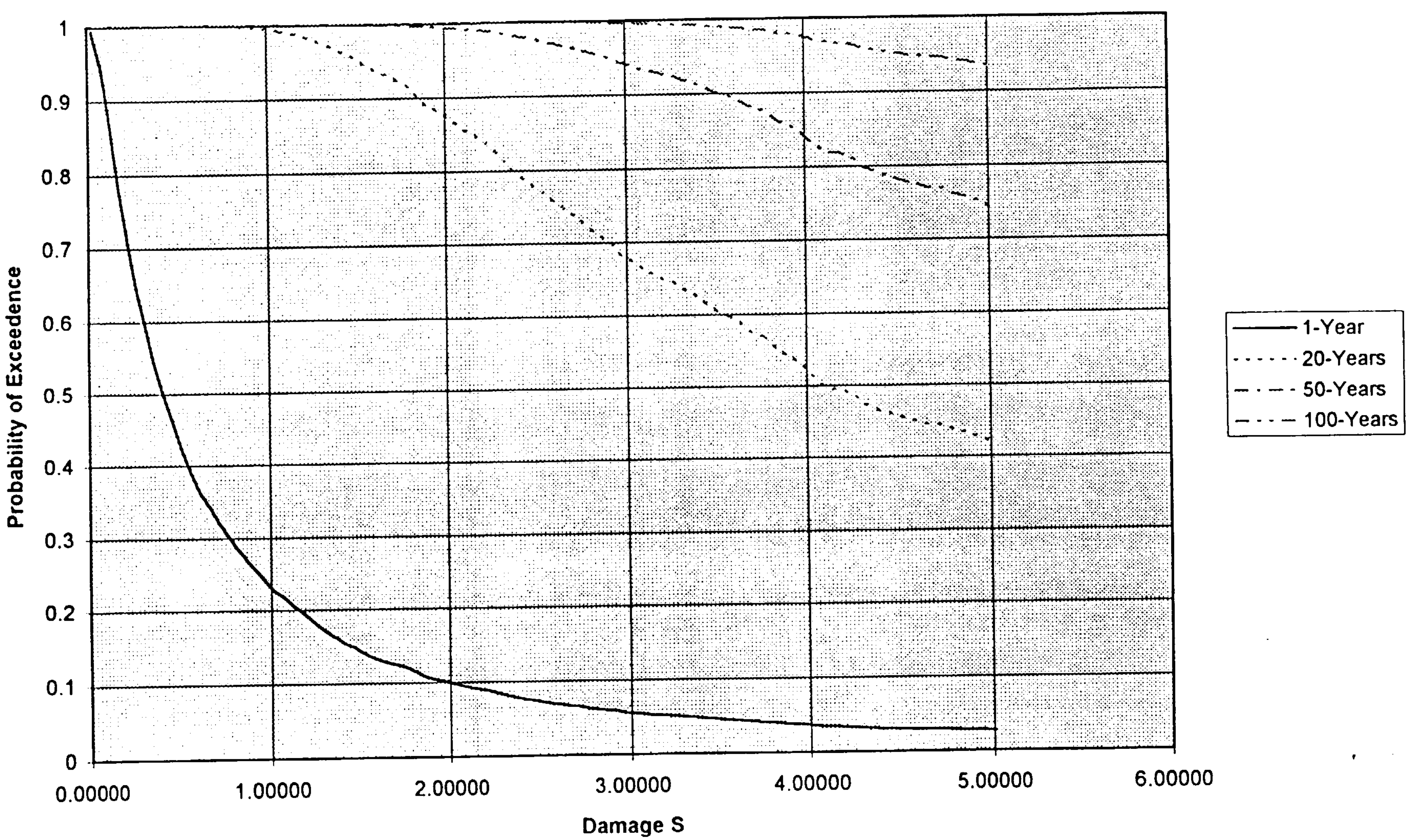


FIGURE 6-14

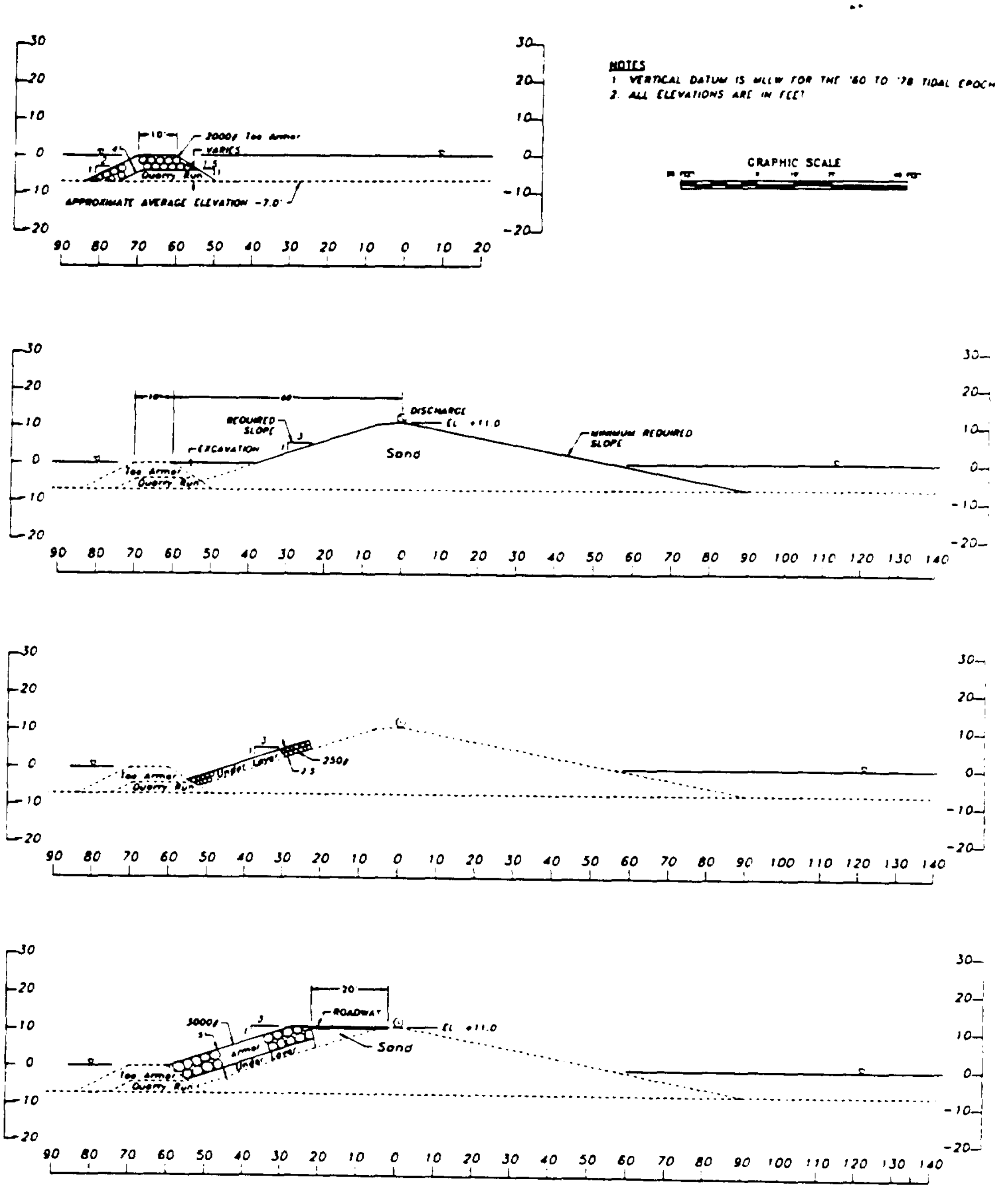


Figure 6-15
WESTERN PERIMETER DIKE
CONSTRUCTION STAGING

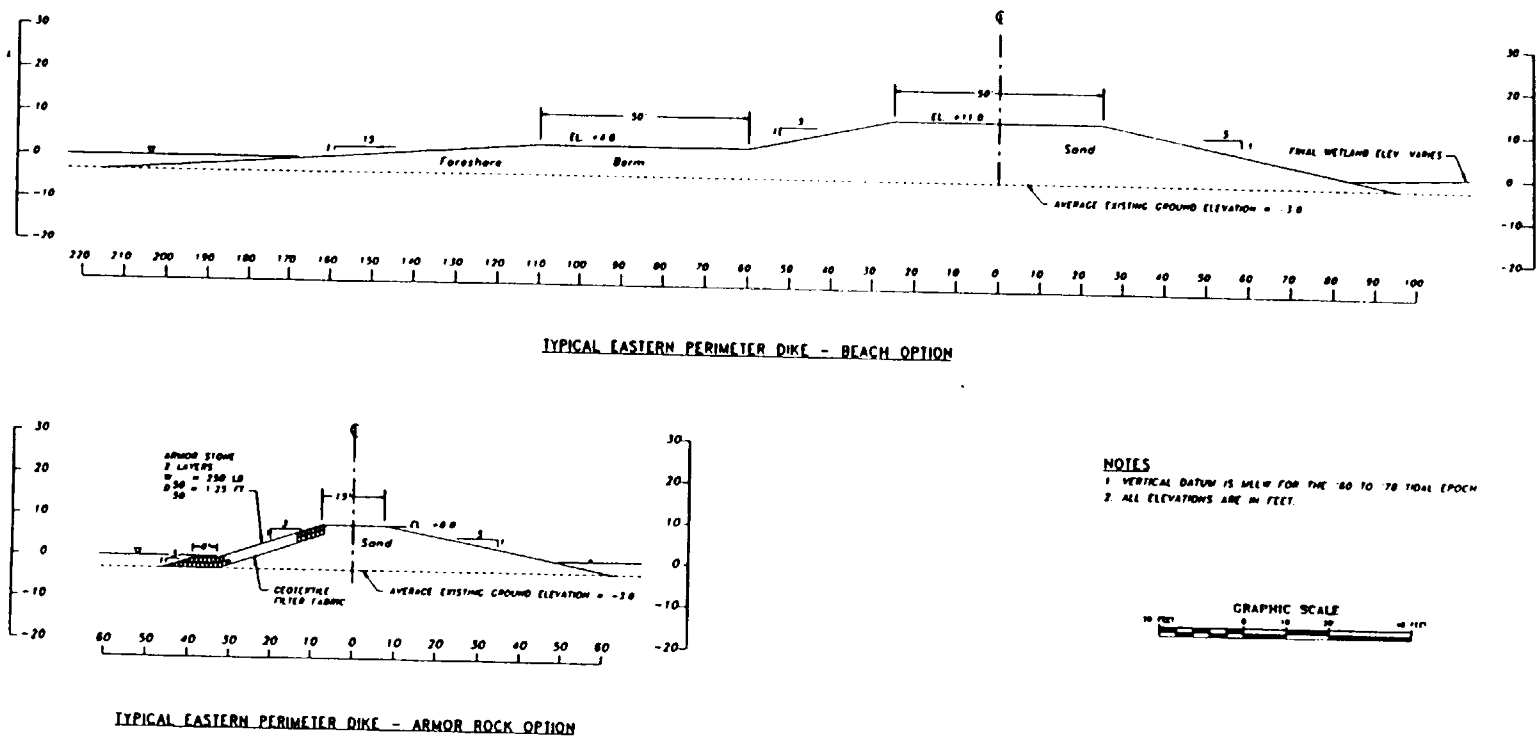


Figure 6-16
EASTERN PERIMETER DIKE

6.1.2.d Water Level Control Structures. Water level control structures will be required to convey excess slurry water from cells during placement and to allow discharge during drying. Control structures are critical to site operations; a proper design will accommodate the raising and lowering of weir boards during cell filling and drying, respectively. Water level control structure configuration will include one or more corrugated metal outlet pipes connected to risers fitted with wooden weir boards to control cell water levels.

Each wetland cell will have two control structures discharging through the eastern perimeter dike to Poplar Harbor and a third control structure discharging through a wetland cross dike into an adjacent wetland cell. Similarly, an upland cell will have two control structures discharging through an upland cross dike into the adjacent wetland cell and a third control structure discharging into an adjacent upland cell. These arrangements will provide maximum flexibility for cell water level control.

No control structures will be located along the western perimeter dikes. The wetland cell control structures discharging through the eastern perimeter dike will be deactivated after the perimeter dike has been breached to introduce tidal flows. The exact size of the breaches is still being evaluated based on tidal exchange. They will likely not be armored. Upland cell control structures will be needed indefinitely to control surface water drainage.

6.1.2.e Cell Design. During the operational life of the site, while filling of the tidal wetland and upland cells is taking place, placement procedures and possibly cell configurations will be adjusted to accommodate actual dredged material volumes. The cell area, volume, capacity, lift thickness, and time to fill relationships are a function of dredged material types, placement, and tidal wetland cell development schedules, as well as the conditions in the cells resulting from previous placements of dredged material. The cell arrangements are shown in Figure 6-17.

Cell characteristics for design objectives are shown in Table 6-3. The site management staff will conduct periodic surveys of cell elevations and cell material water content in order to track the performance of each cell for comparison with design objectives and cell development schedules. An estimate of cell capacity for the six cells is contained in Table 6-3. The actual cut volume being delivered to the site will vary from year to year. The bulked cut volume placed in a cell will determine lift thickness. In general, lift thickness will not exceed 3 feet for upland cells once the material reaches an elevation of MLLW. For wetland cells, lift thickness may be greater, but the placed volume will not exceed that necessary to reach the average finished grade after consolidation of the material.

At a uniform placement rate of 500,000 cubic yards per year, the wetland cells will be filled over a period of approximately 10 years. Individual cells can be filled in one placement season. The final schedule will depend upon filling and consolidation rates, cell planting rates, and the budgets for cell development. Discharges from the upland cell will be channeled to the weirs to avoid potential impacts of fluctuating salinity on the newly formed wetlands.

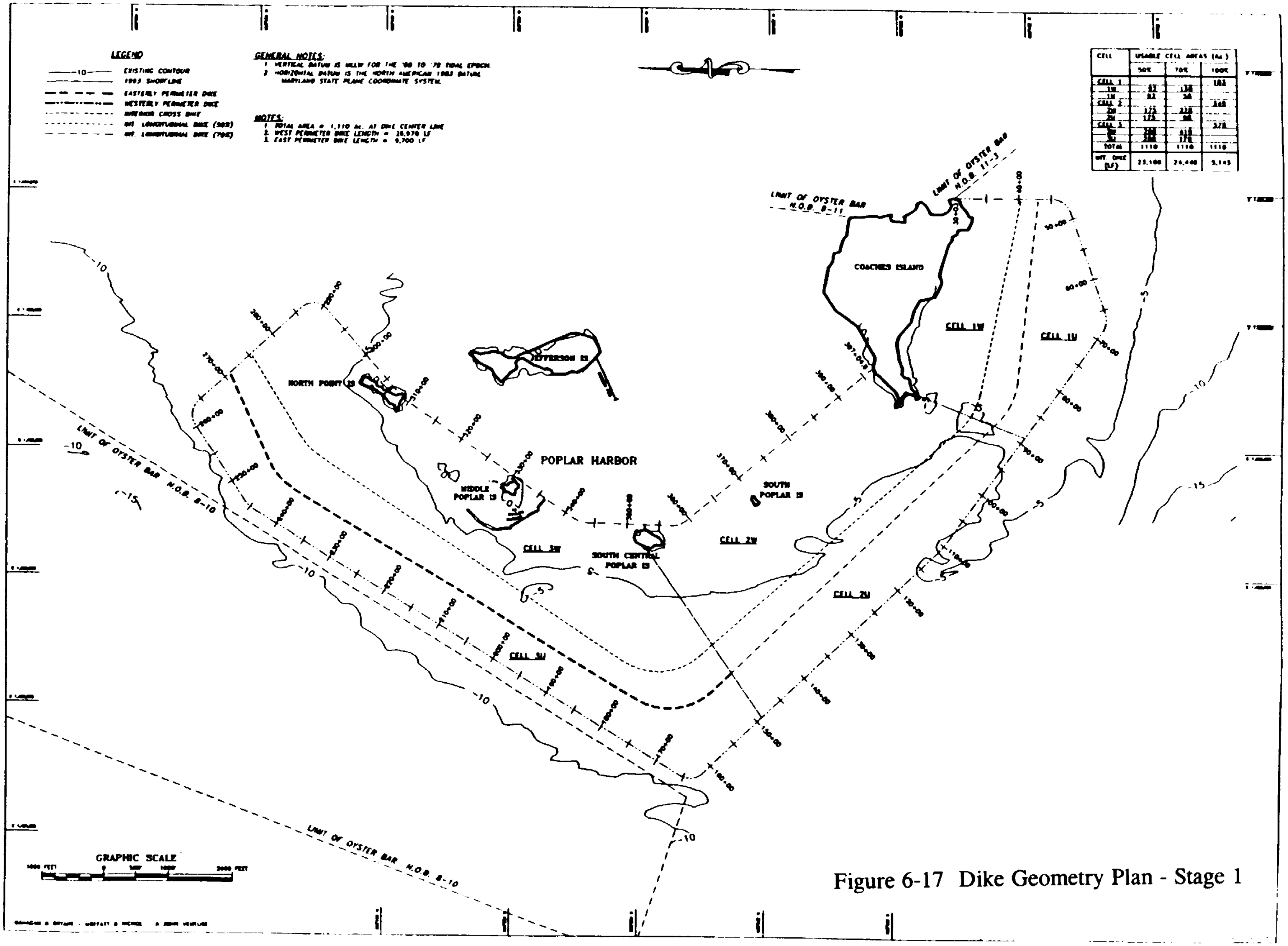


Figure 6-17 Dike Geometry Plan - Stage 1

6.1.2.f Habitat Areas. The overall habitat development footprint will be approximately 1,100 acres. Of this, one half will be upland and the other half will be tidal wetland. Eighty percent of the wetland area will be low marsh and the balance will be high marsh. Low marsh elevations will range from approximately 0.9 feet to 1.5 feet above MLLW, which corresponds to the tidal elevations between Mid Tide (MT) and MHW. High marsh will be at elevations of approximately 1.5 feet to 2.4 feet above MLLW, which corresponds to the tidal range of MHW to MSHW. Marsh elevations will be refined based on onsite tidal gauge data currently being collected. Upland areas will be at elevations up to 20 feet above MLLW. Adjustments to specific habitat locations will be made as needed during the dredging operations.

TABLE 6-3
CELL CHARACTERISTICS
DESIGN OBJECTIVES

No.	Type	Area [1]	Typical Bottom[2]	Elevation Finished	Cell Volume[3]	Cell Capacity[4]
1	Tidal Wetland	175	- 4.7	1.4	1.7	2.37
2	Upland	337	- 7.3	20.0	14.9	23.96
3	Tidal Wetland	139	-3.9	1.4	1.2	1.71
4	Tidal Wetland	87	-3.7	1.4	0.7	1.03
5	Tidal Wetland	140	-3.9	1.4	1.2	1.72
6	Upland	232	-5.5	20.0	9.5	15.39
Subtotal, wetlands		*555*		*1.4*	*4.8*	*6.83*
Subtotal, uplands		*555*		*20.0*	*24.4*	*39.35*
Project totals		***1010***			***29.2***	***46.18***

1. Cell areas are measured to the centerline of the confining dike.
2. Typical bottom elevations may be impacted by borrow activities within each cell.
3. Cell volume (million cubic yards) is the "cubage" of the cell using area and the typical bottom and finished elevations.
4. Cell capacity (million cubic yards) is measured by the channel cut volume which can be placed in the cell when accounting for the consolidation and shrinkage that takes place after placement of dredged materials.

Low Marsh

Low marsh will be dominated by smooth cordgrass (*Spartina alterniflora*). One upland island approximately 2 acres in size will be embedded in the low marsh in each cell. These islands will be surrounded by a channel approximately 50 feet wide, which will contain water 18 to 24 inches deep at low tide. This channel will serve as a "moat" to protect island habitat from predatory species that could disrupt breeding bird populations. It is expected that tidal ponds and dendritic channels will develop throughout the low marsh area, both of which will be 18 to 24 inches deep at low tide. Where channels do not develop naturally, they will be excavated to promote tidal flushing.

High Marsh

High marsh will be dominated by salthay (*Spartina patens*) and other grasses. The high marsh habitat will also include other communities such as rushes (*Juncus* sp.), especially along the upland border. Black needlerush (*Juncus roemerianus*) will more than likely colonize on its own, thereby diversifying the planted wetland community. This species should not be encouraged by planting because introduction before the cordgrasses have become established could result in large monotypic stands of this species, thereby lowering plant diversity. Tidal ponds, which will not be connected to tidal channels, will be constructed in the high marsh. These ponds will be flushed, in general, only during exceptional tide events.

Tidal Ponds

Tidal ponds will be approximately 2 acres in size, with bank slopes of 5:1, and they will be designed to optimize shore bird, wading bird, and waterfowl use. At low tide, approximately 80 percent (1.5 acres) of the low marsh tidal ponds will be 1 foot deep. Ten percent of each pond (0.25 acre) will be deep water refuge 3 feet deep, and the remainder (0.25 acre) will be at a depth of 0.5 foot. Low marsh ponds will be connected to circulating tidal channels.

High marsh ponds will be designed in a similar fashion except that water elevations will be for full pool water elevations. These ponds will be isolated from the daily tidal regime and will only receive tidal water during spring and storm tides. These ponds may dry during seasonal droughts.

Uplands

Upland habitat will support a mixture of forested, scrub/shrub, and nontidal wetland habitat. The contiguous upland habitat will be developed over the life of the project.

6.1.2.g Habitat Development. The following sections briefly describe the proposed approaches for development of habitats on Poplar Island.

Low Marsh Habitat

The dominant vegetation of low marshes in the Chesapeake Bay is the smooth cordgrass (*Spartina alterniflora*). This will probably be one of the dominant species established in low marsh areas of the project. There are several methods by which smooth cordgrass can be established on a site.

Saltmarsh cordgrass will be established on the site by seeding, nursing propagated stock, or placing field-collected sprigs or mats.

Seeds will be collected during the approximate 1-week period effective for this operation. Seed will be threshed and stratified stored in cold salt water for several months during the winter prior to planting.

Nursery propagated peat potted stock will be obtained from contract suppliers. To assure adequate supply, contracts will be let in the growing season prior to planting.

Sprigs and sod mats will be collected from existing smooth cordgrass marshes if needed and if collection impacts can be minimized. Impacts to the source marsh can be minimized by filling the holes left by plant collection with sand, and allowing the remaining plants to "fill in" the gaps.

Smooth cordgrass will be planted by appropriate methods for each propagule type. Seedlings, sprigs, plugs, or mats will be planted on centers or in rows. Unplanted areas will be left in each cell for natural propagation.

High Marsh Habitat

The predominant vegetation on the high marsh will be salthay (*Spartina patens*), with other grasses and rushes (*Juncus* sp.) at the upland/high marsh edge to diversify the habitat. Seeds, seedlings, plugs, and mats will be employed as appropriate and available. Planting techniques will be similar to those employed in low marsh establishment.

In general, peat potted material will be favored. Peat-potted material can be planted almost any time of year, and little post-planting care is required.

Tidal Pond Habitat

Low marsh ponds will be constructed so that at low tide, 80 percent of the area will be covered by one foot of water, 10 percent of the site will be covered by 3 feet of water, and the remainder of the site will be under 0.5 foot of water. High marsh ponds will be constructed with similar attributes, but the above specifications will apply to the pond at full pool. Bank slopes on both pond types will be approximately 5:1. Two ponds are suggested for each wetland cell, one in the low marsh, and one in the high marsh. Pond placement will be dictated somewhat by where dredged material settlement leaves depressions of approximately the correct depths, but some excavation will be required.

Island Habitat

The low marsh area of each wetland cell will include one upland island approximately 2 acres in size (and incorporate existing island remnants where possible), and surrounded by a 50-foot-wide channel 18 to 24 inches deep at low tide. Islands will be constructed by hydraulically placing sand in the wetland cell, and channels will be excavated when conditions permit. Islands will either be planted with a mixture of herbaceous plants and shrubs, or shell will be placed on portions of the island to develop tern nesting habitat. Herbaceous material and vines may include poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), trumpet vine (*Campsis radicans*), blackberries (*Rubus* sp.), and greenbrier (*Smilax rotundifolia*). Trees and shrubs may include marsh elder (*Iva frutescens*), groundsel tree (*Baccharis halimifolia*), wax myrtle (*Myrica cerifera*), and beach plum (*Prunus maritima*). It is recommended that the islands not be sited in close proximity to the upland area or the containment dikes in order to deter access by predators.

Upland Habitat

Uplands will include seasonal freshwater wetlands, forest, and scrub-shrub habitat.

The upland will be contoured to direct rainwater to constructed depressional areas. These areas will collect rainwater during the spring wet season, will initially be planted with herbaceous material that is somewhat salt tolerant, such as Olney's bulrush (*Scirpus americanus*), common three-square (*Scirpus pungens*), and black needle rush (*Juncus roemerianus*). After initial plant establishment, natural succession will result in the edges being dominated by volunteer woody species. Upland pond construction will not occur until the deposited dredged material has sufficiently dried and consolidated, and the sediments are capable of supporting plant growth.

After site conditions improve enough that woody plant species can be established, the upland areas will be planted with species typically found in the region. Trees could include loblolly pine (*Pinus taeda*), red maple (*Acer rubrum*), sour gum (*Nyssa sylvatica*), sweet gum (*Liquidambar styraciflua*), white oak (*Quercus alba*), red oak (*Quercus rubra*), willow oak (*Quercus phellos*), black cherry (*Prunus serotina*), and hackberry (*Celtis occidentalis*). The shrub layer may include wax myrtle, arrowwood (*Viburnum dentatum*), spicebush (*Lindera benzoin*), and sweet pepperbush (*Clethra alnifolia*).

Scrub/shrub habitat will be planted with a mixture of herbaceous plants and shrubs. Herbaceous material and vines may include poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), trumpet vine (*Campsis radicans*), blackberries (*Rubus* sp.), and greenbrier (*Smilax rotundifolia*). Trees and shrubs may include marsh elder (*Iva frutescens*), groundsel tree (*Baccharis halimifolia*), wax myrtle (*Myrica cerifera*), and beach plum (*Prunus maritima*). Natural successional processes may alter the area of this habitat with time.

6.1.3 Project Costs

The total cost is estimated to be $458.4 million. All costs are based on present worth costs as of 1 December 1995. This includes costs for maintenance dredging, placement, shaping and planting of the island, supervision and inspection, execution of the feasibility study, review of the plans and specifications, and advertisement and award of the construction contract (Table 6-4). Maintenance of the Federal navigation project includes the removal, transportation, and placement of approximately 38 million cubic yards of material at Poplar Island. The baseline cost for maintenance dredging and placement in the Deep Trough, the base plan, is currently estimated to be $151.2 million. The incremental project cost is the difference between the total project cost and the base plan cost, which is currently estimated to be $307 million. This number does not include $11 million for state maintenance during construction. The scheduling of these costs are shown in Table 6-5.

6.1.4 Phased Construction

Due to the large costs associated with the Poplar Island Restoration Project and the potential Federal fiscal limitations, a phased construction alternative (Figure 6-18) was considered. If phased, the project would be constructed as follows:

Phase I

The northernmost cells would be enclosed with a full-sized dike encompassing 650 acres, armored on all sides except the east. The borrow areas will, however, be outside of the dike during construction of Phase I. When the dike is completed, dredged material placement could begin. In conjunction with the northern perimeter dike, a stone dike extending along Poplar Harbor to the south shore of Coaches Island would also be constructed.

Phase II

When funding becomes available a second (adjacent) phase would be constructed and armored. Habitat reconstruction could begin on cells in the first phase as soon as the cells are filled. This process would be repeated for the third phase (south of Coaches Island), unless the second phase encompasses the entire area.

While this option would relieve some of the fiscal pressures at the onset of this project, phased construction would be a more costly option over the life of the facility due to the need to maintain incomplete sections of dike, construct more armored sections of dike (around each phase), and mobilize and demobilize additional crews and equipment. It is estimated that Phase I could cost about $47 million. The follow-on cost for Phase II is estimated to be about $31 million. This equates to about a $78 million containment structure, roughly a 10% increase over the cost to build a contiguous placement site. A phased construction approach does allow for several site development options. Phase I would constitute a self-contained placement facility. If funding is not available to complete Phase II, there is a possibility that Phase I may be the only action. If, however, more placement capacity is needed in the future, and funding is available, the remaining acreage could be utilized.

TABLE 6-4

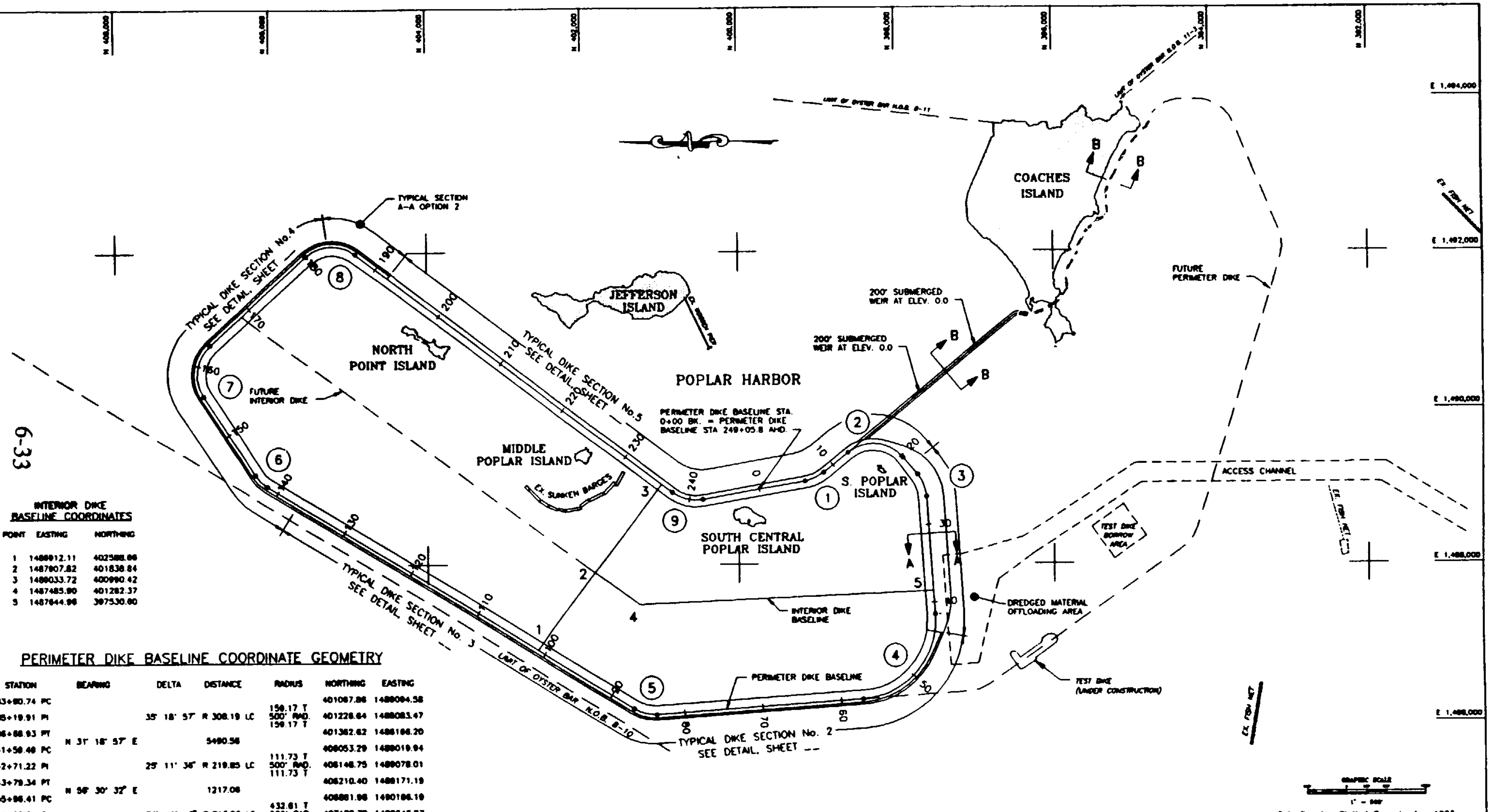
INCREMENTAL PROJECT COST
Poplar Island, Maryland

Section 204 - Beneficial Use of Dredged Material

ITEM	DESCRIPTION	SUB-TOTAL	CONTING.	TOTAL COST
Dredging and Placement Costs				
Dredging				
	Mobilization/Demobilization	$39,840,000	$6,557,000	$46,397,000
	Mechanical Dredging	$245,280,000	$40,369,000	$285,649,000
	Planning, Engineering, Design	$2,304,000	$371,000	$2,675,000
	Construction Management	$5,112,000	$841,000	$5,953,000
Placement Areas				
	Site Work, Mob/Demob, Administration	$15,065,000	$4,023,000	$19,088,000
	Permanent Vegetative Planting	$8,957,000	$2,471,000	$11,428,000
	Cell Closure/Finish	$2,359,000	$614,000	$2,973,000
	Incremental Dike Raise	$2,898,000	$759,000	$3,657,000
	Transportation	$4,750,000	$1,268,000	$6,018,000
	Planning, Engineering, Design	$541,000	$141,000	$682,000
	Construction Management	$3,312,000	$885,000	$4,197,000
Initial Construction				
	Lands and Damages	$73,500	$14,700	$88,000
	Breakwaters and Seawalls	$54,088,300	$13,522,100	$67,610,000
	Planning, Engineering, Design	$301,800	$60,400	$362,000
	Construction Management	$1,084,000	$216,800	$1,301,000
	PROJECT SUBTOTAL			**$458,078,000**
Baseline Dredging and Placement Costs				
Dredging/Transportation				
	Mobilization/Demobilization/Preparation	$10,608,000	$1,742,000	$12,350,000
	Mechanical Dredging	$111,840,000	$18,407,000	$130,247,000
	Engineering, Planning, Design	$2,304,000	$371,000	$2,675,000
	Construction Management	$5,112,000	$841,000	$5,953,000
	BASELINE SUBTOTAL			**$151,225,000**
	INCREMENTAL PROJECT COST			**$306,853,000**
	SAY:			$307,000,000

	Base Years Total	Year 1 Total	Year 2 Total	Year 3 Total	Year 4 Total	Year 5 Total	Year 6 Total	Year 7 Total	Year 8 Total	Year 9 Total	Year 10 Total	Year 11 Total	Year 12 Total
Disposal Areas													
Site Work/Mob, Demob/Admin		$652,000	$652,000	$652,000	$738,000	$692,000	$692,000	$738,000	$784,000	$734,000	$782,000	$803,000	$797,000
Permanent Vegetative Planting						$887,000			$1,230,000	$2,757,000			
Cell Closure											$2,206,000		
Incremental Dike Raise										$403,000	$403,000	$403,000	
Transportation		$238,000	$238,000	$238,000	$238,000	$238,000	$238,000	$238,000	$238,000	$238,000	$238,000	$238,000	$238,000
Planning, Engineering, Design		$46,000	$26,000	$26,000	$26,000	$26,000	$26,000	$26,000	$26,000	$26,000	$26,000	$26,000	$26,000
Construction Management		$149,000	$149,000	$149,000	$149,000	$149,000	$149,000	$149,000	$149,000	$149,000	$261,000	$149,000	$292,000
Dredging													
Mobilization, Demobilization, Prep		$1,909,000	$1,909,000	$1,909,000	$1,909,000	$1,909,000	$1,909,000	$1,909,000	$1,909,000	$1,909,000	$1,909,000	$1,909,000	$1,909,000
Mechanical Dredging		$11,753,000	$11,753,000	$11,753,000	$11,753,000	$11,753,000	$11,753,000	$11,753,000	$11,753,000	$11,753,000	$11,753,000	$11,753,000	$11,753,000
Planning, Engineering, Design		$111,000	$111,000	$111,000	$111,000	$111,000	$111,000	$111,000	$111,000	$111,000	$111,000	$111,000	$111,000
Construction Management		$245,000	$245,000	$245,000	$245,000	$245,000	$245,000	$245,000	$245,000	$245,000	$245,000	$245,000	$245,000
Lands and Damages	$88,000												
Breakwaters and Seawalls	$67,610,000												
Planning, Engineering, Design	$362,000												
Construction Management	$1,301,000												
Total Cost	$69,361,000	$15,103,000	$15,083,000	$15,083,000	$15,169,000	$16,010,000	$15,123,000	$15,169,000	$16,445,000	$18,325,000	$17,934,000	$15,637,000	$15,371,000
Base Plan Costs (Deep Trough)		$6,223,000	$6,223,000	$6,223,000	$6,223,000	$6,223,000	$6,223,000	$6,223,000	$6,223,000	$6,223,000	$6,223,000	$6,223,000	$6,223,000
Incremental Cost	$69,361,000	$8,880,000	$8,860,000	$8,860,000	$8,946,000	$9,787,000	$8,900,000	$8,946,000	$10,222,000	$12,102,000	$11,711,000	$9,414,000	$9,148,000
Federal Cost	$52,020,750	$6,660,000	$6,645,000	$6,645,000	$6,709,500	$7,340,250	$6,675,000	$6,709,500	$7,666,500	$9,076,500	$8,783,250	$7,060,500	$6,861,000
Non-Federal Cost	$17,340,250	$2,220,000	$2,215,000	$2,215,000	$2,236,500	$2,446,750	$2,225,000	$2,236,500	$2,555,500	$3,025,500	$2,927,750	$2,353,500	$2,287,000

	Year 13 Total	Year 14 Total	Year 15 Total	Year 16 Total	Year 17 Total	Year 18 Total	Year 19 Total	Year 20 Total	Year 21 Total	Year 22 Total	Year 23 Total	Year 24 Total	Year 25 Total
Disposal Areas													
Site Work/Mob, Demob/Admin	$797,000	$774,000	$774,000	$826,000	$826,000	$833,000	$833,000	$839,000	$836,000	$772,000	$772,000	$772,000	$718,000
Permanent Vegetative Planting									$2,655,000	$3,375,000			$524,000
Cell Closure/Finish								$255,000	$255,000			$257,000	
Incremental Dike Raise	$403,000	$406,000	$406,000		$409,000	$412,000	$412,000						
Transportation	$238,000	$239,000	$239,000	$241,000	$241,000	$243,000	$243,000	$245,000	$245,000	$247,000	$247,000	$247,000	$247,000
Planning, Engineering, Design	$26,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000
Construction Management	$149,000	$150,000	$150,000	$147,000	$151,000	$152,000	$152,000	$154,000	$154,000	$330,000	$155,000	$155,000	$155,000
Dredging													
Mobilization, Demobilization, Prep	$1,909,000	$1,926,000	$1,926,000	$1,942,000	$1,942,000	$1,959,000	$1,959,000	$1,975,000	$1,975,000	$1,992,000	$1,992,000	$1,992,000	
Mechanical Dredging	$11,753,000	$11,855,000	$11,855,000	$11,957,000	$11,957,000	$12,060,000	$12,060,000	$12,162,000	$12,162,000	$12,264,000	$12,264,000	$12,264,000	
Planning, Engineering, Design	$111,000	$112,000	$112,000	$112,000	$112,000	$113,000	$113,000	$114,000	$114,000	$115,000	$115,000	$115,000	
Construction Management	$245,000	$247,000	$247,000	$249,000	$249,000	$251,000	$251,000	$253,000	$253,000	$256,000	$256,000	$256,000	
Lands and Damages													
Breakwaters and Seawalls													
Planning, Engineering, Desig n													
Construction Management													
Total Cost	$15,631,000	$15,736,000	$15,736,000	$15,501,000	$15,914,000	$16,050,000	$16,050,000	$16,024,000	$18,676,000	$19,378,000	$15,828,000	$16,085,000	$1,671,000
Base Plan Costs (Deep Trough)	$6,223,000	$6,277,000	$6,277,000	$6,331,000	$6,331,000	$6,385,000	$6,385,000	$6,439,000	$6,439,000	$6,493,000	$6,493,000	$6,493,000	
Incremental Cost	$9,408,000	$9,459,000	$9,459,000	$9,170,000	$9,583,000	$9,665,000	$9,665,000	$9,585,000	$12,237,000	$12,885,000	$9,335,000	$9,592,000	$1,671,000
Federal Cost	$7,056,000	$7,094,250	$7,094,250	$6,877,500	$7,187,250	$7,248,750	$7,248,750	$7,188,750	$9,177,750	$9,663,750	$7,001,250	$7,194,000	$1,253,250
Non-Federal Cost	$2,352,000	$2,364,750	$2,364,750	$2,292,500	$2,395,750	$2,416,250	$2,416,250	$2,396,250	$3,059,250	$3,221,250	$2,333,750	$2,398,000	$417,750



INTERIOR DIKE BASELINE COORDINATES

POINT	EASTING	NORTHING
1	1488912.11	402588.66
2	1487907.82	401838.84
3	1488033.72	400990.42
4	1487485.90	401282.37
5	1487644.96	397530.60

PERIMETER DIKE BASELINE COORDINATE GEOMETRY

P.I.	STATION	BEARING	DELTA	DISTANCE	RADIUS	NORTHING	EASTING
	83+80.74 PC					401087.86	1488004.58
5	85+19.91 PI		35° 18' 57"	R 308.19 LC	150.17 T 500' RAD. 150.17 T	401228.64	1488083.47
	86+88.93 PT					401362.62	1488186.20
		N 31° 18' 57" E		5490.56			
	141+50.40 PC					406053.29	1488010.94
6	142+71.22 PI		25° 11' 36"	R 219.85 LC	111.73 T 500' RAD. 111.73 T	406148.75	1489078.01
	143+79.34 PT					406210.40	1489171.19
		N 56° 30' 32" E		1217.06			
	155+96.41 PC					406881.96	1490186.19
7	180+29.01 PI		81° 44' 2"	R 713.29 LC	432.61 T 500' RAD. 432.61 T	407120.70	1490546.97
	183+ 9.67 PT					406797.99	1490835.08
		S 41° 45' 26" E		1686.29			
	179+95.96 PC					405540.06	1491958.11
8	184+ 6.35 PI		78° 45' 26"	R 887.29 LC	410.39 T 500' RAD. 410.39 T	405233.92	1492231.42
	188+83.25 PT					404906.16	1491984.44
		S 37° 0' 0" W		5074.94			
	237+58.19 PC					400853.14	1488930.27
9	239+75.59 PI		47° 0' 0"	L 410.15 LC	217.41 T 500' RAD. 217.41 T	400679.51	1488799.43
	241+88.34 PT					400485.41	1488837.18
		S 10° 0' 0" E		1325.28			
	????????? PC					399180.26	1489067.31
1	????????? PI		28° 33' 35"	L 257.96 LC	131.92 T 500' RAD. 131.92 T	399030.34	1489090.22
	????????? PT					398928.64	1489174.24
		S 38° 33' 35" E		???????			

PI 2	500' RAD.	398230.22	1488751.19
PI 3	500' RAD.	397628.80	1489020.74
PI 4	1000' RAD.	397439.93	1486348.27

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

Figure 6-18

POPLAR ISLAND HABITAT RESTORATION

DIKE GEOMETRY PLAN
STAGE 1

SCALE: 1" = 500' DATE: 9/11/95 SHEET 4 OF 23

PLATE 4

Phased construction is not expected to have any effect on the earth resources in the project area, nor is a phased construction approach expected to alter residence times beyond the minimal increase expected for Poplar Harbor, because the phases are subsets (smaller versions) of the total project. The lack of a full perimeter dike will alter the hydrodynamics, and will also provide less protection for the newly constructed rock dike and south shore of Coaches Island.

Since phased construction will not enclose the borrow area, the area will only be marginally protected from turbidity effects during construction. However, phased construction is expected to have negligible impacts on sediment quality.

Phased construction will lessen the amount of Bay bottom that is buried initially, but in the long term, will result in the same amount of shallow water being shifted to upland/wetland habitats. Potential impacts to water quality and most living aquatic resources would be lessened in the short term, but multiple phase site development would periodically disturb the biota, potentially interfering with recovery times. Constructing the project in phases is expected to produce the same long-term benefits as constructing the total project initially, assuming that all phases are completed, producing a total 555 acres each of new upland and wetland habitats. If the project proceeds using phased construction, the ratio of restored subtidal, wetland, and upland habitat will not change. A phase I only restoration (650 acres) will yield an ecosystem output with the same habitat composition as the overall project but only on a smaller scale.

Although phased construction is expected to protract the short-term effects on phytoplankton, it is expected to have little effect overall. Similarly, phased construction is expected to protract the short-term effects on the fisheries and icthyoplankton but have little effect overall. In terms of bivalves, construction would bury fewer adult stages initially, but would also increase the potential for turbidity impacts over a longer period of time. Phased construction will influence the timing of stabilization of the islands, which will result in a postponement of the project benefits to oysters; however, phased construction is expected to have minimal effects on blue crabs. Overall, a phased approach to construction and dredged material placement could extend the duration of the project and could consequently extend the duration of short-term construction impacts. Although phased construction would prolong and ultimately delay the recolonization period of the benthic community, it is expected to have negligible effects on long-term impacts.

While phased construction activities provide the potential for protracted short-term impacts, dike construction along Poplar Harbor should protect the key SAV area (Poplar Harbor) from phasing effects. Although phasing of construction is not expected to influence vegetative resources, the basic impacts of construction to birds in the Poplar Island area will be disturbance of habitat.

A phased approach to island construction would change aesthetic impacts by limiting the amount of disturbance to a smaller area over a longer period of time. Aesthetically, this approach could protract impacts, too, over a longer time period, but at a lower level and over a smaller area of disturbance. Phased construction could also prolong noise disturbances to Coaches Island due to the need to maintain the sand dikes along the south side of the island. Phasing of construction over a multi-year period could also potentially impact socioeconomic resources for a longer period of time, although a smaller area would be disturbed in each construction increment.

6.1.5 Operation and Maintenance

The construction, operation, and maintenance of the Poplar Island Restoration Project will be a cooperative effort of the USACE, Baltimore District and the Maryland Port Administration. Initial construction and operation of the site will be managed and funded in accordance with Section 204 guidance provided in EC 1105-2-209 (DA 1995); but as each functional element of the project is completed and determined to be functioning as intended, it will become the responsibility of the Maryland Port Administration to operate, maintain, repair, replace, and rehabilitate the given project elements as needed. Such functional elements include the containment dikes; internal dikes; service structures; the access channels; and each of the four wetland and two upland habitat cells. Ultimately the entire site will become the responsibility of the Maryland Port Administration.

6.1.5.a Dredged Material Unloading Arrangements. Dredged material placed at the site will most likely be unloaded hydraulically from the scows in interior access channels. Water depths of 15 to 20 feet will be required for this operation.

An access channel will be dredged from deep water at the southern end of the site through the proposed sand borrow area west of Coaches Island. The channel would extend from the western perimeter dike to a point along the western perimeter dike and southwest of South Central Poplar Island. An initial unloading basin will be constructed southwest of South Central Poplar Island and will provide pipeline access within 10,000 feet of the northern portion of the site. When the cells occupying the proposed sand borrow area are to be filled, the western perimeter dike will be closed, and a second unloading area will be prepared outside the western perimeter dike.

6.1.5.b Site Infrastructure. Site infrastructure will include those site facilities required to support the project dikes and spillways. Infrastructure will include dike roadways, personnel and equipment access and storage areas, and operations and monitoring facilities. Infrastructure will be in place throughout the operational life of the facility.

6.1.5.c Cell Materials Management. Surface slopes of placed dredged materials used in planning the site are based upon experience with fine-grained maintenance materials placed hydraulically at HMI. Surface slopes above water will be 1H:1,000V. Below water they will be 1H:250V. Actual surface slopes encountered during cell filling and consolidation may vary and, thus, require some adjustment in operational procedures.

It is anticipated that no special drying efforts will be required in the tidal wetland cells to achieve a cell surface suitable for development of vegetation. It is also anticipated that, in addition to effectively controlling cell spillways, surface trenching will be required in the upland cells to reach the full drying of the newly placed material required to maximize cell capacity.

6.1.5.d Cell Development and Preparation. After dike construction is completed, clean dredged material will be hydraulically pumped into the cells. Depending on the quality and quantity of the material, more than one cell may be filled at a time. Under many circumstances, cells will be filled using thin "lifts" or layers of 2 to 3 feet of material. Between lifts, the material will be trenched to promote drainage and consolidation. Drying is not expected in low marsh areas.

Under some circumstances, thicker lifts of material may be pumped into the cell. This should be timed to occur only during periods when the cells are initially filled to just above the water line if large amounts of dredged material must be brought to the site.

Islands will be developed by pumping sand into the cells. The sand will be taken from the same borrow areas as the dike material or will be obtained from potential new work dredging areas.

Desalinization

Salts tend to concentrate at the surface of deposited dredged material. As the material dries, capillary action moves water and dissolved salts upward towards the surface, and evaporation leaves the salts behind. The majority of the salt will concentrate at or near the surface, generally within the first 3 inches. This can be a significant problem in any areas that will not be regularly inundated by the tides. This should not be of concern in areas that will be regularly flooded by tidal water, because salts will be readily flushed from the surface during each high tide event.

To promote infiltration, and thus salt leaching, the upland material may be rototilled or disced to loosen the soil. After it has been determined that salinity (and pH) conditions are suitable for plant establishment, an interim vegetative cover will be seeded in the upland areas. Annual rye (*Lolium trifolium*) and panic grass (*Panicum virgatum*) are somewhat salt tolerant. These grasses can be inexpensively seeded on the upland areas after dewatering and initial salt leaching. Lack of high germination rates and/or poor growth of these grasses on the site would be an indication that salt toxicity is still a problem, and additional soil conditioning would be undertaken.

Salt accumulation will not likely be a problem in the marsh areas or islands. If salt toxicity should appear to become a problem, corrective measures will be taken.

Marine sediments may be high in sulfides. When these materials are exposed to air, sulfuric acid forms. The pH can be low enough to inhibit plant growth. Application of lime or other materials (e.g. crushed shells) may be employed to increase the pH if site monitoring suggests acid inhibition of vegetation. This will be of particular concern in the upland cells and will have to be monitored.

If planting is not accomplished when the dredged material is workable, corrective measures may be needed. The silts and clays, upon drying, may become compacted and almost impervious to water. Tilling of the soil by discing or rototilling will be undertaken if required.

6.1.6 Monitoring

Over the life of the project, monitoring will need to be conducted to verify that habitat development is occurring as expected. Each habitat cell will be evaluated twice a year: once early and once late in the growing season. Ground and aerial surveys will be employed to evaluate habitat conditions.

Early season monitoring will verify that the vegetation overwintered successfully. Late season monitoring will determine relative losses and gains in coverage during the growing season.

The monitoring reports will include documentation of any detrimental effects to the habitat development and recommendations on approaches for ameliorating such effects. Wildlife signs and qualitative estimates of relative population will be included in each report. Evidence of storm, ice, or grazing damage, including erosion, heavy wrack accumulation, and the location of any debris that has been deposited on site will be identified and located on sketch maps.

General plant health will be noted as the basis for identifying and implementing correctional actions if necessary. The success of the various planting techniques will be noted as the basis for determining the installation of the subsequent cells. Specific items to be included as they occur will be (1) recruitment of SAV into Poplar Harbor and the tidal ponds, (2) the location of any recruitment of *Phragmites* soil conditions (pirld salinity) and (3) signs of human use of restored habitats. These items will be characterized at each monitoring period. Monitoring reports outlining the results and identifying possible maintenance needs will be submitted after each monitoring period.

Possible maintenance methods include fertilizer application, invasive plant control, pH adjustment, salinity amelioration, wildlife and insect pest control, and human use control.

To insure the integrity of the armored and unarmored dikes, the interior and exterior slopes and roadways will be monitored yearly following severe storm and icing events. Repairs will be made as necessary to the dikes.

Spillways will be monitored hourly during dredged material placement and dewatering operations to ensure the effluent discharge will not exceed state water quality standards for TSS.

Exterior water quality, oyster bars, benthics, fisheries, and sediment monitoring will be conducted as outlined in Section 8 of this report.

6.2 Cumulative Impacts

The beneficial use of the dredged material at Poplar Island has many positive environmental effects. Cumulative negative effects are minor, relatively short term, and of limited severity. Cumulative positive effects and overall benefits to the Chesapeake Bay economic and ecological systems are great and long lasting. The net environmental and economic effects of the project are clearly and demonstrably positive, and there is no potential effect on any cultural or archaeological resources. Thus, the Poplar Island Habitat Restoration Project represents a unique positive solution to difficult environmental, economic, and socio-political problems in the Chesapeake Bay area.

6.2.1 Cumulative Negative Effects

Negative effects of the project are described in detail in Section 5. For evaluating cumulative effects, negative impacts can be grouped in two categories: those affecting the substrate and those affecting the water column.

Substrate impacts will result from the direct placement of dredged material on existing bottoms. These impacts are relatively long term, and will continue through the life of the project. They are relatively small scale, since they are confined to the diked area which is within the historic footprint of Poplar Island. Major ecosystem components potentially affected by substrate impacts are estuarine benthos and SAV. As documented previously, SAV beds are sparse in the project area so adverse impacts will be minimal. Loss of benthos and benthic habitat will be minimal. Due to the very small-scale effects expected on most aquatic resources, cumulative negative impacts on estuarine substrates are of limited concern.

Potential negative impacts on water column resources arise through the loss of such habitat due to the presence of the diked area and localized, short-term increases in turbidity during construction and tug and barge movement. Relative to the total area of open water in the Chesapeake Bay estuary, the project area is very small, and replaces land area that was present historically. The cumulative direct negative impact of the project on water column resources is vanishing. Considered as a whole, including nondirect effects such as enhanced trophic base and breeding areas, the overall net impacts of the project on water column resources will be positive and will add considerably to the valuable open water resources of the mid-Chesapeake Bay region.

6.2.2 Cumulative Positive Effects

Major positive effects of the project result from the re-establishment of wetland and island habitat lost to the Chesapeake Bay estuary by erosional forces over the past century. Important benefits of such habitats include the following:

- High biotic productivity
- Water quality enhancement

- Breeding and foraging support for bird and wildlife populations
- Breeding and foraging support for commercially and recreationally valuable species of finfish and shellfish
- Breeding and foraging support for rare, threatened, or endangered species

These benefits of wetlands and the importance of wetland restoration and construction in providing them are described in detail in *Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy*, NRC 1992. The ecological benefits of wetlands, in turn, support substantial recreational, educational, and research opportunities. The following sections briefly describe the specific benefits of the Poplar Island project. It is important to keep in mind throughout this analysis that the project is simply re-establishing an emergent area formerly present within the historic footprint. On a net cumulative basis, the Poplar Island project will restore to the adjacent Chesapeake Bay estuary a functional ecosystem lost through powerful erosional forces.

Biotic Productivity

Large estuaries in general, and the Chesapeake Bay estuary in particular, function biologically as detritus-based ecosystems (Adam 1990). This means that biological communities are supported by microbially mediated decomposition processes based on macrophytic vegetation (primarily, but not exclusively, tidal marsh macrophytic vegetation [particularly *Spartina* sp.] and the algae directly associated with marshes and mudflats). Many of the valuable functions of estuaries, including nursery functions for fish and shellfish, bird and wildlife habitat establishment, and water quality maintenance processes result directly from the high productivity of marsh plants and tidal linkage of the resulting biomass to the open estuary.

The Poplar Island project will restore to the Chesapeake Bay estuary a substantial increment of biological production. Estuarine tidal marshes are among the most productive habitats on earth (Odum 1983), and the wetland area to be restored at Poplar Island will provide a great quantity of energy (from marsh grass above- and below-ground production, benthic and stem algae, and photosynthetic microbes). In addition, upland areas adjacent to estuarine waters contribute to the high quality detritus base through loss of deciduous materials and litter to the aquatic ecosystem. This energy will, in turn, support the food web that leads directly to production of striped bass, croaker, weakfish, spot, bluefish, blue crabs, oysters, soft clams, and other important finfish and shellfish in the central Bay.

Water Quality Enhancement

Under present conditions, the remnant emergent islands and bars of the former Poplar Island are eroding continuously under the influence of various hydrologic forces. The eroded soils and sediments are transported in the water column throughout the Poplar Island area of the Chesapeake Bay. These suspended solids degrade open water habitat and make the local aquatic ecosystem stressful for many species. High suspended sediment loads abrade the gills of fish and shellfish, smother oyster beds, reduce light penetration and primary productivity, are avoided by foraging predatory species, and limit the area (often to the periphery of the plume, which may be a focal point for feeding) utilized by prey species.

Restoration of Poplar Island will reduce the ongoing degradation of water quality in the central Bay associated with the erosional transport of shoal sediments and island remnants. The dike systems being constructed for the dredged material containment are specifically designed to resist the erosional forces that destroyed Poplar Island over the past century. They are designed also to allow tidal flux and outflow for nutrient uptake and detrital transport by the marsh. By reducing a key source of suspended solids transport, it is expected that the restoration of Poplar Island will substantially enhance water quality and thus enhance the use by and production of important finfish and shellfish.

Bird and Wildlife Habitat

When island upland and wetland habitat is lost, associated regional biodiversity is reduced. The loss of Poplar Island, in particular, resulted in the reduction (to date) and potential elimination (within the near future) of important breeding and foraging habitat for waterfowl, wading birds, and wildlife species. This loss has both specific and cumulative impacts on Chesapeake Bay biological communities. The specific aspects of these losses are not inconsequential. Their significance is magnified when considered in the context of ongoing and rapid regional habitat loss. For many of the species that formerly utilized Poplar Island, the total available habitat in the Bay is shrinking as a result of development throughout the basin. Each available habitat area, and island habitats in particular, increases in value under such circumstances. Islands provide refuge for many species. The reduced access limits human disturbance, reduces or eliminates predation by such native and invasive species as fox and raccoon, and stabilizes the noise environment. Thus, the loss of Poplar Island has had and continues to have serious consequences for the overall ecological health of bird and wildlife populations in the Chesapeake Bay region.

Restoration of Poplar Island will provide diverse habitats suitable for many species of birds and wildlife. The island design, directly incorporating upland and wetland and developing nearshore shallows in association, will maximize the habitat value for a number of key species. On a cumulative basis, this will restore to the central Bay, the mid-Atlantic region, and the Atlantic flyway as a whole, a significant increment of population for a number of important bird and wildlife species.

Finfish and Shellfish Habitat

One of the most important functions of estuarine wetlands and nearshore environments is their role as nursery and foraging grounds for finfish and shellfish. The loss of Poplar Island has had some complex effects on these functions in the central Bay. On a transient basis, erosion has exposed habitat structure in the nearshore vicinity of the former island that provides cover for some species of recreational and commercial interest. However, this structure will be present for only a very short time. The erosional forces that destroyed Poplar Island will, in the near future, destroy or transport away this habitat cover. The shoal and shore habitat in place near the remnants of Poplar Island are limited in the functional support provided to aquatic resources. This is because they lack the crucial detrital input that drives the estuarine ecosystem, and that requires adjacent wetlands and uplands to provide the production base. On a cumulative basis, the present configuration of Poplar Island is attractive to, but not productive of, harvestable resources. Thus, this area can contribute to the catch, but not to the production necessary to support the catch. In the relatively near future, even the attractor of habitat structure will be lost unless restoration is undertaken.

On a cumulative basis, reconstructing Poplar Island will restore to the central Bay the full complement of linked habitats necessary for effective, long-term nursery and trophic support of finfish and shellfish. The complex of upland, wetland, nearshore, and shoal habitats that will be designed or that will develop in response to the island configuration will offer a diversity of habitat resources. These habitats will provide the trophic foundation, cover, and behavioral foci for propagation and nursery functions and attraction and concentration of harvestable adults. Thus, the Poplar Island restoration will contribute to both the production and focused harvest of resource species.

Rare, Threatened, and Endangered Species Habitat

Habitat for listed bird species is presently sparse and degrading in the vicinity of the former Poplar Island. With the exception of transient (nonbreeding) birds, only bald eagles nesting at Jefferson Island are present. Construction and dredged material placement activities will be implemented in such a way to minimize disturbance to this site (Section 5.4.8).

Transient listed bird species or species of concern observed in the vicinity of the proposed restoration include the least tern (Western populations federally listed, Maryland populations not listed or protected), the rare hooded merganser, and the rare sharp-tailed sparrow. As a focus for foraging, resting, or breeding by species of concern, the remnants of Poplar Island are poor and declining habitat. The diversity of such species in the area, and the contribution of the area to their habitat support, is presently low and will decline as the island remnants continue to erode.

The restoration will provide diverse and high quality habitat for a number of species of concern not presently found in the area. Some of these were likely present in historical times prior to major losses of emergent upland and wetland from Poplar Island. Among taxa likely to benefit from the restoration are wading birds, waterfowl, raptors, and song birds. The restored island may be particularly important as foraging or resting ground for such species as the black rail and northern harrier. Bald eagle, sharp-tailed sparrow, least tern, gull-billed tern, and several heron species will benefit from the protection and provision of breeding areas.

In addition to bird species, marine mammal and fish species that are listed as endangered for the northeast region of the U.S. include: right whale, humpback whale, fin whale, sei whale, Kemp's ridley sea turtle, leatherback sea turtle, green sea turtle, and shortnose sturgeon. Loggerhead sea turtles are listed as threatened in the region. These threatened and endangered species are considered occasional or transient in the Chesapeake Bay and are not likely to occur within the project area.

Protection of Adjacent Islands

Wind-driven waves, which are responsible for the current erosion of the archipelago, will continue to erode any exposed landmasses in the region. Erosion will be greatest along unprotected shorelines exposed to prevailing winds. Prevailing winds in this region throughout most of the year are from the north or northwest. Southern winds can, however, be extreme in some seasons, particularly summer. Shorelines can typically be protected in three ways: (1) by armoring with stone or bulkheading, (2) by using groins or breakwaters to diffuse the destructive forces of wave energies, or (3) by stabilizing through the use of vegetation. The reconstructed Poplar Island will act as a breakwater for the other islands in the chain (Coaches and Jefferson), while providing a protected cove that will encourage development of a biotic community intolerant of high wave action.

The reconstructed island will protect Poplar Harbor from wind-driven waves originating from all directions except the east. Jefferson Island will benefit from this protection along its west and southwest shorelines (adjacent to the harbor) and may even accrete some material along these shorelines. The reconstructed island is also expected to diffuse the worst of the waves generated from a northwest direction, affording some protection to Jefferson Island along the northwest shore. Poplar Island, however, will not protect the northern or eastern shorelines of Jefferson Island.

The proposed island will provide protection to the highly-exposed western and southern shoreline of Coaches Island where the most significant erosion to Coaches Island has taken place in recent years. Most of the northern shore of Coaches Island is protected by Jefferson Island and a rip-rapped shoreline. No protection of the eastern shoreline would be expected from the proposed action.

6.2.3 Cumulative Effects Summary

Cumulative negative effects of the dredged material placement and Poplar Island restoration will be minimal. Some local effects associated with loss of present bottoms and open waters can be expected, but such habitats are relatively extensive in the region, and the project will have little significant impact.

Cumulative positive effects and overall benefits to the Chesapeake Bay economic and ecological systems will be significant and long-lasting. Major economic benefits are associated with the provision of maintained channel access to the Port of Baltimore. The Poplar Island restoration employing dredged material will provide additional economic benefits from recreational and commercial activities supported by the restored habitats.

The Baltimore District has never constructed a beneficial use site of this magnitude or even a smaller beneficial use site in the project area. Future use of existing Bay islands beneficial use sites is unlikely for the Baltimore Harbor and Channels project because of the high transportation cost. The construction of Poplar Island will provide capacity for dredged material which would have to be placed in other ways i.e.; open water or upland placement. Poplar Island would lessen the impacts sometimes associated with open water or upland placement.

Hart-Miller Island near Baltimore is a confined placement site approximately 1140 acres in size, the size of the proposed Poplar Island project. It was originally designed for contaminated sediments and material form the 50-foot project although much of the material placed within the site is considered clean. It is not comparable to Poplar Island because Poplar Island was designed for beneficial use/wetlands creation and Hart-Miller was designed for recreation and wildlife use after placement is completed.

As described in Section 2 acceptable placement sites are in short supply and the need to maintain channels in the Bay is great. The Corps of Engineers and the MPA through the DNPOP and the DMMP are working with other agencies to identify placement needs and will look at beneficial uses for dredged material when possible.

Cumulative environmental benefits of the restoration will accrue throughout the central Chesapeake Bay area and the mid-Atlantic region. High quality, island-based wetland and upland habitat will support commercially and recreationally valuable finfish and shellfish; birds and wildlife; and rare, threatened, and endangered species. Water quality will improve as present erosion is eliminated, and the reconstructed island will provide erosion protection for adjacent islands in the group.

The effective coordination between the need for navigational dredging and the need for habitat restoration at Poplar Island provides an opportunity for long-term cumulative benefits to both the economic and ecological resources of the Chesapeake Bay region.

6.3 Environmental Compliance

For a placement site to be environmentally acceptable, the location, design, and operation must be in compliance with a suite of environmental protection statutes and executive orders. Table 6-6 outlines the statutes and executive orders that are potentially applicable to the project, including the level of compliance. The multiple organizations involved in the project and the ongoing and open communication surrounding decisions have helped ensure complete compliance with potentially applicable statutes and regulations.

The proposed action complies with applicable cultural resources statutes, including the state Archaeological and Historic Preservation Act and the National Historic Preservation Act. The assessment included evaluation of archaeological and historic resources, economic and social impacts, and interaction with coastal planning regulations. The Maryland State Historic Preservation office has been consulted and concurs that the project is in compliance.

The technical impact assessment documented in this report demonstrates that the project complies with applicable components of the Anadromous Fish Conservation Act; Clean Air Act; Coastal Barrier Resources Act; Coastal Zone Management Act; Estuary Protection Act;

Table 6-6 Compliance of the Proposed Action with Environmental Protection Statutes and Executive Orders

Statutes	Level of Compliance
• Anadromous Fish Conservation Act	Full
• Archeological and Historic Preservation Act	Full
• Clean Air Act	Full
• Clean Water Act	Full
• Coastal Barrier Resources Act	Full
• Coastal Zone Management Act	Full
• Comprehensive Environmental Response, Compensation, and Liability Act	N/A
• Endangered Species Act	Full
• Estuary Protection Act	Full
• Federal Water Project Recreation Act	N/A
• Fish and Wildlife Coordination Act	Full
• Marine Mammal Protection Act	Full
• Marine Protection, Research, and Sanctuaries Act	Full
• National Environment Policy Act	Full
• National Fishing Enhancement Act	Full
• National Historic Preservation Act	Full
• Resource Conservation and Recovery Act	N/A
• Rivers & Harbors Act	Full
• Watershed Protection and Flood Prevention Act River and Harbor Flood Control Act	N/A
• Wild and Scenic Rivers Act River and Harbor Flood Control Act	N/A
Executive Orders	
• Protection and Enhancement of Environmental Quality (Exec. Ord. No. 11514, 1977)	Full
• Protection and Enhancement of the Cultural Environment (Exec. Ord. No. 11593, 1971)	Full
• Floodplain Management (Exec. Ord. No. 11988, 1977)	Full
• Protection of Wetlands (Exec. Ord. No. 11990, 1977)	Full
• Federal Compliance with Pollution Control Standards (Exec. Ord. No. 12088, 1978)	Full
• Intergovernmental Review of Federal Programs (Exec. Ord. No. 12372, 1982)	Full
• Environmental Justice (Exec. Ord. No. 12898, 1994)	Full

Full Compliance: Having met all requirements of the statute or E.O. for the current stage of planning.

N/A: No requirements for the statute or E.O. for the current stage of planning

National Fishing Enhancement Act; Marine Protection, Research and Sanctuaries Act; and the Rivers and Harbors Act. The proposed action will be in full compliance with the Clean Water Act when the State of Maryland issues a water quality certificate or if Congress approves the EIS prior to construction. At the present time, the Corps intends to apply for a water quality certificate. No significant impacts are expected to any rare, threatened, or endangered species; the project complies with the Endangered Species Act and the Marine Mammal Protection Act.

The project also complies with all components of NEPA. Through the intensive coordination process, the project complies with the Fish and Wildlife Coordination Act.

A number of executive orders are applicable to the project. The impact evaluation process demonstrates that the project complies with Executive Orders number 11593 (1971), Protection and Enhancement of the Cultural Environment; number 11514, Protection and Enhancement of Environmental Quality; and number 12088, Pollution Control Standard.

The nature and design of the project explicitly incorporate compliance with Executive Orders number 11988, Floodplain Management, and number 11990, Protecting Wetlands.

The project will have no significant impact on minority or low-income communities, and complies with Executive Order number 12898, Environmental Justice. Further, the Working Group has involved the residents of Talbot County in the decision-making process via a series of public meetings.

Through coordination with the applicable state and Federal agencies, it was determined that no National Point Discharge Elimination System permit or Federal wetlands permit will be required for the project unless the state constructs the project on its own. The design and implementation of the project may also preclude the necessity for a state wetlands permit; the only permitting required may be documentation of compliance with the Coastal Zone Consistency Plan.